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INCREASING THE WEAPONIZATION OF SPACE
A PRESCRIPTION FOR FURTHER PROGRESS

by

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Preface

I've had a general interest in the space weapon topic since my early years in the Air Force, when I worked on satellite survivability techniques; this interest grew while working on various directed energy weapon programs funded by the Strategic Defense Initiative. My interest sharpened, and I developed some specific thoughts on space weapons, while working as the Space Control Program Element Monitor in SAF/AQSD for Maj. Gen. Moorman in the late 80's. It's an understatement to say that Gen. Moorman inspired some of my deepest thinking – as well as longest hours – while working jointly with the Army and Navy on a reincarnated kinetic energy (KE) anti-satellite program. The fact that the program emerging from that effort – the Army's KE ASAT program – is still limping along is at least partly responsible for my efforts in this paper. If I can add any impetus to the development of space weapons – and the emerging national discussion on this topic certainly suggests that there will be some form of development – I will consider the effort well spent.

I am indebted to a number of people for their help and encouragement, and want to let them know in print how much it means to me. First and foremost, my wife Kellie and daughter Shannon endured many hours of separation while I researched and wrote this paper, and I truly appreciate their patience, support, and love. In a less personal but nevertheless vital way, I'm indebted to Col. (sel) Tom Clark, the Air War College Space Chair, for his support, not just with ideas and research material, but also for helping make

the connection with my official USSPACECOM/J3 sponsor, Maj. Gen. Kelly. Gen. Kelly provided both his personal insight and his organization's support for my research, both of which aided me significantly. Of particular note, Major Marti Fallon, USSPACECOM/J35, was very helpful on the USSPACECOM Long Range Plan. Lt. Col. Connie Lintz, AF Space Battle Lab, also helped track down information on the MIRACL laser. My other sponsor, the Center for Strategy and Technology at Air University, provided their own insight and inspiration to the topic, as well as more mundane but vital editing commentary: I'm grateful to Dr Bill Martel and Col. (ret) Ted Hailes for their time and expertise. And at the Air University library, many people were very patient and helpful during my visits there. In addition, Major Jeff Rockwell of AF/JA provided selected legal material; Col. (ret) Meeks of SAF/GC provided helpful background information. Finally, for my basic interest in the topic, I'd like to once again cite Gen. Moorman for his early and continuing inspiration, and note that Lt. Col. (sel) Marty Whelan, SAF/SN, prompted me to take on this issue for my research paper since it was so timely and important. I hope the work following this acknowledgement makes the foregoing people proud of their contributions: if so, it will in a small way repay their help; if not, the failing is of course mine, and doesn't diminish the superior aid they rendered me.

Abstract

This paper explores the impediments that prevent DOD from further developing space weapons and recommends actions DOD can take to mitigate/eliminate these impediments. The history of space, and in particular space weapons, is addressed to eliminate likely incorrect impressions and lay the foundation for later discussions. Six major joint and AF future warfare reports/studies (*JV 2010*, the Quadrennial Defense Review report, the National Defense Panel report, *New World Vistas: Air and Space Power for the 21st Century, 2025*, and *Air and Space Power in the New Millennium*) are discussed in terms of their predictions for increasingly-important space activities in general and the value of space weapons in particular. Then a taxonomy for space weapons is developed, encompassing space control (satellite protection and negation) and force application (worldwide missile defense and worldwide precision strike). Five types of impediments (policy, strategy, legal, organizational, and feasibility) are then matched to the space weapon taxonomy, showing how various missions and weapon types/basing modes are effected. Finally, recommendations are made on how DOD can mitigate the impediments; these recommendations are assessed for the effort needed to accomplish them and brief statements are made on what DOD can do once the recommendations are implemented.

Chapter 1

Introduction

Our actions regarding space over these next few years will set the course for the next quarter century. Decisions we make today will make all the difference in our adaptation to the world's future security environment and the Space and Air Force that our children and grandchildren inherit.

—General Howell M. Estes III, USCINCSpace

Space has great potential to improve the defense capabilities of the U.S. However, DOD is not able to explore the full potential of space due to both internally and externally imposed constraints. These constraints apply primarily to the “weaponization” of space, which has periodically been a topic of intense discussion in the U.S., and is once again on the “hot list.” Weaponization is a timely issue because of space-based options for National Missile Defense (NMD) as well as calls in several future military capability studies for advanced space-based weapons to protect and negate space systems and to conduct other types of force application from space.¹ And the U.S. is not the only major nation that has recently discussed the great potential of space weapons. In the last few years, several Chinese military officers and defense civilians have predicted the inevitability of space combat in the 21st Century and have called for Chinese developments in this area.² The time seems ripe to evaluate what must be done to make further progress on space weaponization.

To fully explore the potential of space in contributing to the national defense, DOD must in effect support the removal of the existing internal and external constraints. Removal of internal constraints will be straightforward and relatively easy once DOD acknowledges the improvement in defense capabilities that results from this action. Removal of external constraints requires persuasive advocacy by DOD to the senior Executive and Legislative Branch leadership imposing the constraints, and will certainly require a higher level of effort than removal of the internal DOD constraints. Both these actions are possible because further weaponization of space is not only consistent with basic U.S. security goals and fundamental beliefs on the appropriate way for nations to interact, but also in keeping with the trends of more controlled and effective application of military force.

The underlying assumption of this paper is that further weaponization of space will provide a net increase in the future security of the United States. The foundation of this contention is the belief that pursuing weaponization offers the U.S. unique capabilities for both protecting U.S./allied/friendly space assets as well as taking the fight to an aggressor. The increasingly large national space infrastructure is becoming a vital interest for the U.S. that must be protected.³ Space weapons would provide unique ways to defend U.S. space assets (and the homeland, in the case of National Missile Defense) from attacks. Space weapons would also provide significant enhancements in flexibility and weapon performance when the U.S. had to counterattack. These benefits could be achieved while not appreciably increasing the threat posed by potential adversaries, because the dynamic of adversary weapon development is now driven more by their perception of areas of asymmetric advantage than it is by trying to mirror image an

acknowledged area of U.S. superiority. And, as important as these military effectiveness reasons, weaponization can be pursued without undermining the U.S.' moral position in the world. Stated another way, this means that there is no inherent moral reason prohibiting the U.S. from weaponizing space to perform legitimate military functions more effectively. On the contrary, because of the potential for both defensive capability against attacks on space infrastructure and the homeland as well as highly-precise offensive capability, space weapons offer a more effective way to conduct those legitimate operations that the U.S. government must engage in, minimizing both U.S. and adversary casualties and associated destruction. In the future, subsequent to actual definition of specific space weapon system concepts, a space weapon advocate may be able to argue persuasively that there is a moral imperative to select the space weapon option over the less-effective, greater collateral damage terrestrial option to accomplish some mission. The fact that this outcome is indeed plausible suggests that there should be a strong moral compulsion now to evaluate all potential space and terrestrial weapon system concepts in a fair and equitable process. However, without removal of the impediments currently in place that inhibit the weaponization of space, this trade-off between terrestrial and space weapon options will not be equitable. This occurs because the military services are unlikely to devote sufficient resources to fully understand the space weapon options that advancing technology is making increasingly available if there is no significant chance for such weapons ever to be built, tested, deployed, and, if necessary, used. Consequently, certain changes need to be made to the current environment to enable full exploration of space weapons, with the potential for pursuit of

selected options all the way through the acquisition cycle and into the field, where they would be fully ready for use if called upon.

Motivated by the belief that the U.S. will want some types of space-based weapons in its kit bag to deal with future threats, this paper identifies the types of missions that space weapons might reasonably be expected to perform. Then the paper identifies what changes in the environment are needed to permit the appropriate level of research and development (R&D) to occur. Based on information from a prudent R&D effort, including realistic test results, DOD will be able to make an objective trade-off analysis between space-based and terrestrial weapons. With this information, senior U.S. decision-makers could decide how far to pursue weaponization of space, given national security interests and the world situation. Consequently, the paper will make recommendations for actions that could be accomplished easily (where DOD is not using the full flexibility within its control now), as well as both moderate-effort (primarily for DOD internally-controlled constraints) and high-effort (primarily for externally-controlled constraints) changes to the constraints on weaponization that will enable further progress to be made.

Notes

¹ Dr. Gene H. McCall and Maj Gen (ret) John A. Corder, *New World Vistas: Air and Space Power for the 21st Century Summary Volume* (Washington, DC: 15 December 1995), 46-47. See also 2025 Support Office, *2025 Executive Summary*, 1996, 24-26; on-line, Internet, 14 February 1998, available from <http://www.au.af.mil/au/2025/monographs/E-S/e-s.htm>.

² Chang Mengxiong, "Weapons of the 21st Century," *Chinese Views of Future Warfare* (Washington, D.C.: National Defense University Press, 1997), 252. See also Naval Captain Shen Zhongchang, Naval Lieutenant Commander Zhang Haiyin, and Naval Lieutenant Commander Zhou Xinsheng, "21st-Century Naval Warfare," *Chinese Views of Future Warfare* (Washington, D.C.: National Defense University Press, 1997), 263 and 265. In addition, see Senior Colonel Wang Baocun and Li Fei, "Information Warfare," *Chinese Views of Future Warfare* (Washington, D.C.: National Defense

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University Press, 1997), 337-8. And Major General Wu Guoqing, "Future Trends of Modern Operations," *Chinese Views of Future Warfare* (Washington, D.C.: National Defense University Press, 1997), 344 and 352-3.

³ Honorable William S. Cohen, *Report of the Quadrennial Defense Review*, 1997, 3 and 15 in Section III: Defense Strategy; on-line, Internet, 3 December 1997, available from <http://www.defenselink.mil/pubs/qdr/sec3.html>. See also Phillip A. Odeen et al, *Transforming Defense: National Security in the 21st Century*, 1997, 14 and 39, on-line, Internet, 3 December 1997, available from <http://www.defenselink.mil/topstory/ndp.html>.

Chapter 2

Background

No one can flatter himself that he is immune to the spirit of his own epoch, or even that he possesses a full understanding of it. Irrespective of our conscious convictions, each one of us, without exception, being a particle of the general mass, is somewhere attached to, colored by, or even undermined by the spirit which goes through the mass. Freedom stretches only as far as the limits of our consciousness.

—Dr. Carl Gustav Jung

Prior to identifying the missions that space weapon systems might compete for, and the impediments keeping them from doing this effectively, it is first necessary to review some background. The space age officially began with the launch of Sputnik on 4 Oct 1957.¹ This is significant because it was only 40 years ago: that means that key government leaders, not only in the U.S. Executive and Legislative branches, but also in most nations around the world, have been alive for the entire time that man has had access to space. Going further, the entire space age is most likely in the living memory of these key leaders, since it is not unreasonable to expect most of them are at least 50 years old. Consequently, the entire history of space is likely to be known to these leaders personally; in fact, it is not so much history as simply personal memory! Therefore, they are likely to have some definite opinions and beliefs about space, whether they may consciously realize it or not. Since these opinions and beliefs may have been formed

early, and only reinforced (positively or negatively) by subsequent space activities, it is necessary to review the history of space prior to proceeding.

This space history review is crucial because it establishes the context in which arguments about policy and legal constraints will occur. The history review will be done in three major parts. The first part will discuss the highly publicized aspects of the civilian/commercial space effort with which a large percentage of the globe's population is familiar. The second part will discuss the less well-publicized military/intelligence space effort. The third part will discuss the history of space weapons, which has had much less exposure to the general population, but is critically important to understanding the true state of space and the real nature of the space weaponization debate. The history review will conclude with an observation on which space events are most likely to have made impressions on key leaders.

Introduction to Space History

The Beginnings of the U.S. and U.S.S.R Space Programs

The history of man's interest in space likely goes back beyond the origins of writing, and several key historical figures – Ptolemy, Copernicus, Galileo – are known to modern people because of their theories regarding the earth and its place in space.² But, while people have long looked up into the heavens and wondered, mankind's ability to do more than that is very recent, confined solely to the 20th Century. In fact, only since the late 1950's, with the development of powerful rockets, has there been an ability to overcome the earth's gravitational pull sufficiently to place an object in orbit around the globe. The Russians first achieved this feat, with their Sputnik satellite, on 4 Oct 1957, with the

“beep” literally heard around the world.³ This feat, while catching the imagination of the world in general, caused significant concern in the U.S. for national security reasons: if the Russians could place a satellite in orbit over the U.S., they presumably could also drop a nuclear weapon out of the sky onto the U.S.⁴ Therefore, the very first space event had major national security repercussions while not, strictly speaking, being a military space flight. The spur of Sputnik prompted the U.S. to accelerate both its intercontinental ballistic missile and space efforts, resulting in the first U.S. satellite in orbit, Explorer 1, on 31 Jan 1958.⁵ Many more launches would follow quickly.

The history of the U.S. and U.S.S.R. space efforts are addressed below, divided into civil/commercial, military/intelligence, and space weapon sections. Within the U.S., the agencies the three key agencies responsible for these categories were the National Air and Space Agency (NASA), the National Reconnaissance Office (NRO), and the DOD. In addition to the U.S. and U.S.S.R. efforts, the space programs of other nations of the world will also be discussed. Though these “rest of world” programs have primarily involved civil/commercial efforts, there are some military satellites, and at least one author reports a claim that Iraqi space weapon efforts have also occurred.⁶

Civil/Commercial Space History

Early Years of U.S. and U.S.S.R. Civil/Commercial Space Programs

The movement of mankind into space enabled the U.S. and U.S.S.R. to extend their competition for world primacy into the heavens. A spectacular series of space “firsts” resulted over the next few years after Sputnik. These events are summarized in Table 1, which shows how the two superpowers raced to reach farther and farther into space, as

well as to get man – and woman – into orbit. The twelve years between Sputnik and Apollo 11's landing on the moon were literally the “golden age” of space flight and excited the imagination of billions of people worldwide. But, at the same time, there were other things going on in space – things hardly anyone knew about – that were nevertheless momentous despite their highly secretive nature. These activities are discussed later, in the section on military/national security space efforts, after the discussion of the civil/commercial space program is complete.

Table 1. Key Early Civil/Commercial Space Events

Date	Satellite	Significance
4 Oct 1957	Sputnik 1	First satellite in space; launched by U.S.S.R.
31 Jan 1958	Explorer 1	First U.S. satellite
17 Mar 1958	Vanguard 1	U.S. satellite transmitter experiment
12 Sep 1958	Luna 2	First satellite to hit moon; launched by U.S.S.R.
1 Apr 1960	Tiros 1	First weather satellite; launched by U.S.
12 Apr 1961	Vostok 1	First man in space; launched by U.S.S.R.
5 May 1961	Freedom 7	First U.S. man in space
16 Jun 1963	Vostok 6	First woman in space; launched by U.S.S.R.
18 Mar 1965	Voskshod 2	First space walk; launched by U.S.S.R.
3 Jun 1965	Gemini 4	First U.S. space walk
15 Dec 1965	Gemini 6	First space rendezvous; launched by U.S.
3 Feb 1966	Luna 9	First soft landing on the moon; launched by U.S.S.R.
2 Jun 1966	Surveyor 1	First U.S. spacecraft to soft land on moon
24 Apr 1967	Soyuz 1	First space fatality; crash of U.S.S.R. spacecraft
20 Jul 1969	Apollo 11	First manned landing on moon; launched by U.S.

Source: *History of Space Exploration*, n.p., on-line, Internet, 24 November 1997, available from <http://nauts.com/histpace/histpace.html>.

Later Years of the U.S. and U.S.S.R. Civil/Commercial Space Programs

The civilian space program did not end with the U.S. flights to the moon; it instead started to widen and diversify. The global public's imagination had been captured by space – not to mention the interest of governments and industry for national and business purposes – and support for space science and emerging business opportunities led to

more nations getting into the space business. Table 2 shows the highlights of the years between 1969 and 1997.

Table 2. Key Later Civil/Commercial Space Events

Date	Satellite	Significance
11 Apr 1970	Apollo 13	Explosion in space; U.S. moon mission aborted
19 Apr 1971	Salyut 1	First space station in orbit; launched by U.S.S.R.
23 Jul 1972	Landsat 1	First earth resources satellite; launched by U.S.
14 May 1973	Skylab	First U.S. space station
17 May 1974	SMS-1	First geosynchronous weather satellite; U.S.
17 Jul 1975	Apollo/Soyuz	First international spacecraft rendezvous
16 Oct 1975	GOES	First geosynchronous environmental satellite; U.S.
19 Feb 1976	Marisat 1	First commercial maritime satellite; U.S.
12 Apr 1981	STS-1	First manned space shuttle flight; U.S.
19 Jun 1983	STS-7	First U.S. woman in space
6 Apr 1984	STS-41D	First in-space satellite repair (Solar Max); U.S.
28 Jan 1986	STS-51L	Space Shuttle <i>Challenger</i> explodes on launch; U.S.
29 Sep 1987	STS-26	First shuttle flight after <i>Challenger</i> accident
9 Jan 1990	STS-32	Space shuttle retrieves Long Duration Exposure Facility and returns it to earth
2 Dec 1993	STS-61	First servicing mission for Hubble Space Telescope
Feb 1994	STS-60	First Russian cosmonaut flies on space shuttle
26 Jun 1995	STS-71	First time U.S. space shuttle docks with Russian MIR space station

Sources: Compiled from *History of Space Exploration*, n.p., on-line, Internet, 24 November 1997, available from <http://nauts.com/histpace/histpace.html>; and Matthew J. Von Bencke, *The Politics of Space: A History of U.S.-Soviet/Russian Competition and Cooperation in Space* (Boulder, CO: Westview Press, 1997), 217-34.

The Rest of the World in Space

The U.S. and the U.S.S.R. were not the only nations in space: once the fundamental feasibility had been demonstrated, many nations developed space efforts. In the bi-polar world of the 1960's, many of these efforts were closely related to those of one of the superpowers, but as time went on, more and more indigenous capability was developed and other nations' space efforts became more independent. China, France, Great Britain, India, Japan, Italy, Canada, Israel, and others all developed space programs. All these

involved satellite development; a few, namely, Japan, China, India, France, and Israel, also developed the launch vehicles to put these satellites in orbit. The information in Table 3 summarizes some of the key events from the space programs of other nations.

Table 3. Key “Rest of the World” Space Events

Date	Satellite	Significance
26 Apr 1962	Ariel 1	First international cooperative satellite; U.S./Great Britain (on U.S. launcher)
Sept 1962	Aloutte	First Canadian satellite (on U.S. launcher)
15 Dec 1964	San Marco 1	First Italian satellite (on U.S. launcher)
26 Nov 1965	A-1 (Asterix)	First French satellite
17 May 1968	ESRO-2B	First European Space Research Organization (ESRO) satellite
8 Nov 1969	Azur	First West German satellite (on U.S. launcher)
24 Apr 1970	SKW-1 (DFH1)	First Chinese satellite
31 May 1974	COS-B	First European Space Agency (ESA) satellite
19 Apr 1975	Aryabhata	First Indian satellite (on U.S.S.R. launcher)
9 Sep 1975	ETS-1	First Japanese satellite
23 Nov 1977	Meteosat-1	First ESA weather satellite
11 May 1978	OTS-2	First ESA telecommunications satellite
18 Jul 1980	Rohini 1B	First Indian satellite launched on Indian rocket
16 Jun 1982	ECS-1	First ESA operational telecommunications satellite
Feb 1986	SPOT 1	First French earth resources satellite
17 Mar 1988	IRS-1a	First Indian earth resources satellite
19 Sep 1988	Offeq 1	First Israeli satellite
17 Jul 1991	ERS-1	First ESA earth resources satellite
Oct/Nov 1993	EUROMIR	First joint ESA/Russian manned space flight
7 Jul 1995	HELIOS	First French reconnaissance satellite (w/Italy and Spain)

Sources: Compiled from *All About the European Space Agency: Some Dates*, n.p., on-line, Internet, available from <http://www.esrin.esa.it>; Adnrew Wilson, ed., *Interavia Space Directory 1989-90* (Geneva, Switzerland: Interavia SA, 1989), 1-47; and “Outlook/Specifications: Spacecraft,” *Aviation Week & Space Technology*, 8 January 1996, 126.

The largely civilian nature of these programs, especially the advertised parts of them, further reinforced the emphasis on the “peaceful” use of space that was understood worldwide due to the heavily advertised successes of the U.S. and U.S.S.R. civil/commercial space programs. However, it is important to note that the military uses

of systems such as the French SPOT satellite have been documented and the French themselves are not shy about touting the military utility of SPOT in its marketing brochures.⁷ Nevertheless, the space activities of the “Rest of the World” are largely advertised as non-military, and are popularly viewed that way.

Military/Intelligence Space History

Early Years of the U.S. and U.S.S.R. Intelligence Space Programs

The Sputnik launch showed the Soviets could boost a heavy payload into orbit around the earth, and implied another, much more threatening capability. The potential for a huge space rocket to launch a nuclear warhead, rather than a satellite, caused significant concern within the U.S. national security apparatus. The immediate result was a heightened interest in penetrating the “denied territory” of the U.S.S.R. to determine what the Soviets were doing – how many missiles did they have and how fast were they being built and deployed. Since the previous method of collecting intelligence information from “denied territory” – overflights by U-2 high-altitude reconnaissance aircraft – had both physical and diplomatic risks, satellites were eagerly pursued as the next generation intelligence system.⁸ The CORONA Program, with its Discoverer satellites, went into high-gear, and, coupled with the equally high-priority development effort for launch vehicles, soon led to a series of attempts to place a camera system into orbit.⁹ After many disappointments and problems, Discoverer XIV achieved orbit on 18 Aug 1960 with the first working photo-reconnaissance camera system, which then ejected its film canister on 19 Aug after 17 earth orbits, producing in the process the first useful intelligence photos from space.¹⁰ The Discoverer program then conducted more than a

decade of flights, with the last mission, the 145th, launching on 25 May 1972 and capsule recovery occurring on 31 May.¹¹ These flights provided a wealth of information about the Soviet Union during a time of intense concern about emerging nuclear capabilities, and enabled the U.S. to make decisions about national security from a more informed perspective. But this satellite information was also used by the military for warfighting purposes: namely, targeting of Soviet nuclear missiles and bombers.¹² This was the first use of satellite information by the military, but, due to the unacknowledged nature of satellite reconnaissance at the time, this military use was not widely known by more than a handful of people accessed to highly classified information. The situation was similar on the Soviet side, when their first photo-reconnaissance satellite, Zenit-2, successfully returned its film from orbit in April 1962. Much like Discoverer, Zenit was reported as a scientific satellite and its actual mission kept secret.¹³

Though the U.S. National Security Space Program went on to other significant achievements, none of the authors who have written about these highly-classified, extremely low profile programs has claimed that they undertook weapon-related activities. This assumption will also be extended to the Soviet space program, though it is not at all clear their efforts actually could be separated into “national security” and “military” space efforts in the same way the U.S.’ can. Nevertheless, Soviet space weapon activities will be discussed later, in the same context as the U.S. military’s space weapon activities. And, since the recently declassified information on the CORONA Program has already established that the U.S. military did use satellite reconnaissance data for targeting purposes (and almost certainly the Soviets did the same thing with Zenit data), the link between the military and intelligence space programs has been made.

This link is important for documenting what has in reality happened in space and it will be discussed again later in this chapter when we address the definition of weaponization of space. But, continued exploration of the Intelligence Space Program is not pertinent to a discussion of the general population's understanding of space activities, so this paper does not need to discuss this topic any further. Therefore, it turns to other, less sensitive U.S. satellite programs that emerged with a clear, acknowledged connection to the military.

U.S. and U.S.S.R. Military Space Efforts

The Army, Navy, and Air Force all had satellite programs in the late 50's and early 60's, and all had a strong interest in space.¹⁴ However, the Air Force competed most successfully for the mission, and newly elected President Kennedy quickly tasked the U.S.A.F. with "research, development, test, and engineering of Department of Defense space development programs or projects."¹⁵ Nevertheless, all three Services had their own satellites in the early years of the space program, as can be seen in Table 2.3. However, after a few years, the Army dropped out and the AF assumed prominence in the military space business, with the Navy having a continuing, but smaller, role. The first military satellites established space missions that are still vitally important to the defense establishment today: communications (Army's Project SCORE satellite in 1958); navigation (Navy's Transit satellite in 1960); ballistic missile early warning (AF's MIDAS satellite in 1960); nuclear detonation reporting (AF's Vela Hotel satellite in 1963); and meteorology (AF's DSAP satellite in 1963).¹⁶ During this same period, the Soviets launched primarily the same mission-type of military satellites, though on a

somewhat later schedule than the U.S.: meteorology (1963); communications (1964); navigation (1967); and missile early warning (1971).

There followed several decades of increased use of space by both the U.S. and Soviet militaries, as shown in Table 4. The satellites in this table were nominally for “peaceful” (i.e., defensive or non-aggressive) purposes, and did not include weapons (though they were understood to enhance the effectiveness of weapon systems – the classic force enhancement role of space systems).

Table 4. Key Military/Intelligence Space Events

Date	Satellite	Significance
18 Dec 1958	Score	First communication satellite; U.S.
13 Apr 1960	Transit 1B	First navigation satellite; U.S.
24 May 1960	Midas 2	First early warning missile detection satellite; U.S.
10 Aug 1960	Discoverer 13	First recovered satellite payload; U.S.
18 Aug 1960	Discoverer 14	First reconnaissance photos from space; U.S.
31 Jan 1961	Samos 2	First successful radio transmission reconnaissance satellite; U.S.
16 Mar 1962	Cosmos 1	First Soviet military satellite
26 Apr 1962	Cosmos 4	First Soviet reconnaissance satellite
1963	DSAP	First U.S. military weather satellite
17 Oct 1963	Vela Hotel	First satellite for detecting nuclear explosions; U.S.
23 Apr 1965	Molniya 1	First Soviet communication satellite (probable)
25 Jun 1966	Cosmos 122	First Soviet weather satellite (probable)
6 Nov 1970	DSP 1	First launch of new generation early warning missile detection satellite; U.S.
1971	DSCS II	First DSCS II communication satellite launch; U.S.
29 Dec 1973	Cosmos 626	First Soviet radar ocean reconnaissance satellite
1982	DSCS III	First DSCS III communication satellite launch; U.S.
14 Feb 1989	GPS-1	First launch of GPS satellite; U.S.
7 Feb 1994	Milstar	First launch of Milstar communication satellite; U.S.

Sources: Compiled from Matthew J. Von Bencke, *The Politics of Space: A History of U.S.-Soviet/Russian Competition and Cooperation in Space* (Boulder, CO: Westview Press, 1997), 209-34; “Outlook/Specifications: Spacecraft,” *Aviation Week & Space Technology*, 8 January 1996, 126; *Fact Sheet: Defense Satellite Communications System*, 1, on-line, internet, 24 November 1997, available from http://www.laafb.af.mil/SMC/PA/Fact_Sheets/dscs_fs.htm; Adnrew Wilson, ed., *Interavia Space Directory 1989-90* (Geneva, Switzerland: Interavia SA, 1989), 267; and *Fact Sheet: Defense Support*

History of Space Weapons

Definition of Space Weapons

The topic of this paper, the weaponization of space, implies the development and fielding of space weapons. This begs the question, what are space weapons? Consequently, to set the context, prior to discussing the history of space weapons, the term itself must be defined. This paper's definition, as consistent as possible with many similar definitions which have been proposed in the course of United Nations-sponsored discussions on the topic, is:

Space weapon: either (1) a device, located in space at the time of its attack, that is designed to damage or harmfully interfere with the normal operation of a target located anywhere (in space, in the air, on the ground, underground, on the sea, or under the sea); or (2) a device, located anywhere, designed to damage or interfere with the normal operation of a target in space (where space means the volume 90 kilometers or more above the earth's surface).

There are several key phrases in this definition which warrant notation (these are also explored in more detail in Appendix A). The first is the "located in space at the time of its attack" phrase, which indicates the weapon is in space when it executes its attack on a target; it doesn't matter whether the weapon is orbiting the earth or on a ballistic trajectory. The second is the "device designed to" phrase, which indicates an intent by the device's developers to create a weapon capability. This phrase is used to distinguish devices that are designed to be weapons from other devices that might be able to be used

in some way to exert force on a target, even though such a capability was not intended by their designers. Said another way, many devices can be used as weapons in an extreme contingency, but these devices were not designed and built with the intent to be weapons and they have a primary purpose other than to perform a weapon's function, so they are not defined as weapons here. The third is the "harmfully interfere with the normal operation" phrase, which indicates an intent to cause a detrimental impact on a target's operations, whether it be temporary and reversible or permanent and irreversible. And the fourth is the "target in space" phrase, which indicates that any object that is in space at the time of the attack, whether in orbit or merely on a transitory ballistic path, makes the attacking device by definition a space weapon. These phrases are likely to elicit some concern because they create a space weapon definition that is either more or less restrictive than some might prefer: this situation is recognized and any resulting criticism is acknowledged. The discussion in Appendix A provides rationale for the choices made in the definition of a space weapon.

Early History of Space Weapons

...if the Soviets control space they can control the earth, as in the past centuries the nation that controlled the seas dominated the continents....We cannot run second in this vital race. To insure peace and freedom, we must be first.

—Senator John F. Kennedy

Originally the idea of using weapons in space was viewed negatively and was given limited support by the Eisenhower Administration.¹⁷ Nevertheless, research and development related to both anti-ballistic missile and anti-satellite weapons occurred. Project Argus, a highly classified series of three nuclear tests which exploded bombs at about 300 miles altitude over the South Atlantic in Aug/Sep 1958, measured weapon

effects which provided data to U.S. anti-ballistic missile efforts.¹⁸ The hoped-for effects of the test – to create a “space umbrella” that killed all incoming nuclear warheads - were disappointing from an ABM perspective, and alternate intercept strategies had to be pursued.¹⁹ Also, on 13 Oct 1959, the Air Force fired a Bold Orion missile on a trajectory that passed through the orbital path of Explorer VI, gathering data useful for anti-satellite system design.²⁰ Nevertheless, Pres. Eisenhower was unconvinced that an U.S. ASAT system was required, and would not allow DOD to proceed far enough to field one.²¹

However, early in the Kennedy Administration, events prompted a change in this position on ASAT. The Soviets started development of a Fractional Orbital Bombardment System (FOBS) with the potential to place a nuclear warhead in orbit.²² This threatened to reduce the warning time for a nuclear attack to effectively zero, and was therefore viewed with the gravest concern. To counter this potential threat, the U.S. explored two anti-satellite (ASAT) systems and eventually developed a nuclear-armed ASAT that could shoot down a FOBS satellite prior to its passage over the U.S.²³ This U.S. ASAT, known as Project 437, was stationed on Johnston Island in the Pacific Ocean in 1965. Soon after, with Soviet signing of the Outer Space Treaty, which had provisions restricting stationing of weapons of mass destruction in space, the Project 437 system lost its primary reason for being. However, it remained in mothball status until 1975, when it was finally dismantled.²⁴

Later Years of Space Weapons

There is an interesting “coincidence” associated with the final shut-down of the U.S. ASAT on Johnston Island: the Soviets started testing a conventionally-armed ASAT system in 1968 and stopped testing it (temporarily, as it turned out) in 1972.²⁵ However,

not quite a year after the U.S. ASAT was scrapped, the Soviets started testing their ASAT system again, early in 1976.²⁶ This Soviet system, designed to negate U.S. satellites in low-earth orbit, was itself a satellite, which went into a similar orbit to its target, then exploded a warhead which launched shrapnel at the target satellite, destroying it on impact. The Soviets tested this co-orbital ASAT 20 times over a period of 14 years, with occasionally long breaks between test series.²⁷

Partly in reaction to the Soviet co-orbital ASAT, and partly in recognition of the force-enhancement support that Soviet satellites provided to their terrestrial forces, President Ford authorized work on a conventionally-armed ASAT in 1976.²⁸ This new U.S. ASAT was launched from an F-15 aircraft and flew directly to its target, striking it with enough force to destroy the satellite on impact. This contrasted with the Soviet system in several ways: (1) the U.S. system was basically a small sub-orbital missile which flew into the path of the much higher velocity satellite, vs. the Soviet system, which was an actual satellite itself and had to be launched on a regular launch vehicle; (2) the U.S. system impacted the target satellite directly, vs. the Soviet system, which exploded a warhead some distance away and let the shrapnel hit the satellite; (3) the U.S. system relied on an optical seeker, vs. the Russian ASAT having two versions, one with radar and the other with an optical seeker; (4) the U.S. system had limited altitude reach, but could theoretically be flown out of most airfields around the world, vs. the Russian ASAT, which had much higher altitude reach but had to be launched out of a fixed space launch facility; and (5) the U.S. system could theoretically attack a satellite at any time since it could go to the right spot on the globe, vs. the Soviet ASAT which had to wait for

the satellite target to fly over the Soviet Union within intercept range of the co-orbital ASAT.

Neither the U.S. nor Soviet ASAT systems were ever declared operational by their governments, though both had successful tests against target satellites (the Soviets had 9 of 20 successful intercept tests, the U.S. had 1 of 1).²⁹ However, the U.S. evaluated the Soviet ASAT to have an operational capability, reporting on it in a series of “Soviet Military Power” threat assessments between 1981 and 1990; there is still a concern that the Russians could use the system in a contingency role if necessary.³⁰ The U.S. system was cancelled after its one successful intercept test for a variety of reasons, including cost/schedule performance, continued Congressional opposition to testing, and a change in the Soviet threat. A decision was made that maintaining the five R&D missiles in storage was too expensive, so the U.S. capability was lost at program termination.³¹

In addition to the specifically identified ASAT systems of both the U.S.S.R. and the U.S., there have been several other examples of “weapons” being used in space or being developed for use against targets in space. Both Soviet and U.S. laser facilities have been flagged as having potential abilities to irradiate satellites, thereby causing interference with the satellite’s mission. The recent interest in the Mid Infrared Advanced Chemical Laser (MIRACL) test against the MSTI 3 satellite (in Oct 1997) was so high because some parties believed this test was intended to be a demonstration of ASAT capability (see Appendix B for a discussion of this issue).³² On the Soviet, now Russian, side, there were evaluations done by the U.S. intelligence community, consistently reported in the annual *Soviet Military Power* reports of 1984 – 1990, that at least two Soviet ground-based lasers had at least some contingency ASAT capability.³³ The GALOSH ABM

system around Moscow was also evaluated to have a collateral ASAT capability as early as 1964; it is possible this ABM system still has a residual capability.³⁴ And the Soviets were also suspected of having radio-frequency (RF) weapon technology that could damage satellites and reentry vehicles.³⁵ The U.S. also demonstrated another type of kinetic energy anti-satellite vehicle. In 1986, the Strategic Defense Initiative Office (SDIO) conducted a space-intercept test in its Delta 180 experiment, demonstrating the ability of the U.S. to very rapidly field a contingency capability to do a kinetic energy intercept of an orbiting object with another orbiting object (in some ways similar to the Soviet co-orbital ASAT, though with an actual satellite-to-satellite collision rather than a shrapnel kill).³⁶

Beyond the aforementioned anti-satellite weapons, whose purpose was to attack satellites in orbit, there are also ballistic missiles and anti-ballistic missile weapon systems. Under commonly anticipated operation, ICBMs and their payloads merely transit space, on a ballistic (i.e., non-orbital) trajectory on their way to an Earth target, and are therefore not space weapons (neither the weapon nor the target are in space at the time of the attack). If the RVs on ICBMs were fused to detonate in space (as has been proposed for some advanced nuclear weapons), then they would qualify as space weapons. Anti-ballistic missiles (ABMs) are a somewhat different case, since some of them have their weapon effect above the sensible atmosphere, in space, against ballistic targets. When an ABM system attacks a target in space, whether it is an in-coming nuclear RV or a satellite (e.g., the GALOSH in its primary ABM vs. contingency ASAT role), it is a space weapon. Several ABMs have had the range to reach space targets, including the Soviet's GALOSH and America's Nike Zeus and Spartan.³⁷

Finally, the last category of systems that needs to be discussed includes those systems with non-weapon missions that could nevertheless be used to apply force against another nation's satellites if the need arose. These do not qualify as space weapons under the definition of this paper, but have nevertheless been charged with a collateral weapon capability during the course of space arms control discussions by various parties. The U.S. space shuttle is the principle example of this category of dual-use system: the Soviets have expressed their concern about the shuttle's potential weapon role, and it was a sticking point in early discussions about possible bi-lateral ASAT arms control agreements.³⁸ The ability of the shuttle to match course with a satellite, and the recently demonstrated ability for the shuttle crew to even retrieve a tumbling satellite, only confirms that the shuttle could indeed be used to take action against certain low-earth orbit satellites under restricted circumstances. This type of example gets to the heart of the issue between *intent* and *capability* mentioned in the definition section above: the shuttle was not designed, developed, and fielded to be an ASAT, but it nevertheless has the capability to perform (very limited) ASAT attacks. This collateral, unintended capability of certain space (and missile) systems makes problematic the verification of many otherwise interesting potential ASAT arms control agreements, but has been dealt with summarily in this paper through the space weapon definition's restrictive nature.³⁹

Having reviewed the key space weapon efforts, the events of space weapon history are captured in Table 5 below. While only U.S. and U.S.S.R. programs are shown, it is important to note that any nation with a space launch system (India, China, Japan, Israel) could seek to duplicate either the Strategic Defense Initiative's Delta 180 experiment in a crash program. And, beyond that, at least one author postulates that any country with a

moderate-range theater ballistic missile could try to do a direct ascent attack with a shrapnel warhead and have some finite probability of actually hitting a satellite.⁴⁰

Finally, news reports on the Army's recent laser tests against the MSTI 3 satellite suggest that even low-power lasers could be effective at disrupting the performance of some satellite sensors: such lasers are widely available and could be used by many nations in an attempt to prevent satellite observation of key locations.⁴¹

Table 5. Key Space Weapon Events

Date	Weapon	Comment
27 Aug 1958	Project Argus	First in series of three nuclear detonations at about 300 miles altitude to measure effects of nuclear blast in space; other two tests on 30 Aug and 6 Sep 58; gathered data useful for ABM development
13 Oct 1959	Bold Orion	First U.S. "ASAT" test with Bold Orion missile crossing orbital path of Explorer VI satellite
4 Mar 1961	Galosh ABM	First Soviet ABM intercept test; go on to field with high-altitude intercept and contingency ASAT capability
1963	Nike Zeus	Pres. Kennedy approves start of nuclear-armed ASAT program; declared operational in 1964; cancelled in 1966
1963	Thor IRBM	Pres. Kennedy approves start of nuclear-armed ASAT; declared operational in 1964 on Johnston Island; put in mothball status in 1970; dismantled on 1 Apr 1975
Sep 1966	Fractional Orbit Bombardment System (FOBS)	Soviets begin tests on FOBS; system designed to put nuclear weapon in orbit for a fraction of one revolution to enable a short-warning attack on U.S.; 18 tests conducted between 1966 and 1971 (9 in 1967 alone)
20 Oct 1968	Co-orbital ASAT	Soviets begin testing on co-orbital interceptor; first series of tests runs until 3 Dec 1971
16 Feb 76	Co-orbital ASAT	Soviets resume testing co-orbital interceptor; second series of tests runs until 18 Jun 1982
10 Jun 1984	Homing Overlay Experiment (HOE)	U.S. conducts successful intercontinental ballistic missile re-entry vehicle intercept in space using an optical seeker with a non-nuclear warhead

Date	Weapon	Comment
13 Sep 1985	Miniature Homing Vehicle (MHV) ASAT	U.S. MHV ASAT successfully intercepts P78-1 science satellite
27 Apr 1986	Information Warfare	“Captain Midnight” hacks into Home Box Office’s Galaxy 1 satellite and inserts message protesting scrambling of cable TV signal
5 Sep 1986	Delta 180 Experiment	U.S. conducts successful intercept of orbital target with rapidly built interceptor experiment for Strategic Defense Initiative
25 Jun 1990	Relay Mirror Expt. (RME)	U.S. successfully relayed laser beam from ground site to satellite and back down to second ground site
8 Oct 1997	MIRACL low-power tests	U.S. conducts low-power laser tests against sensors on MSTI-3 satellite using tracking lasers at Mid-infrared Advanced Chemical Laser (MIRACL) test site; conduct second test on 21 Oct 1997
17 Oct 1997	MIRACL high-power test	U.S. conducts high-power laser test against sensors on MSTI-3 satellite using the MIRACL high-power laser

Sources: Compiled from Cecil Brownlow, “Soviets Prepare Space Weapon for 1968,” *Aviation Week & Space Technology*, 13 November 1967, 30; Andrew Wilson, ed., “FOBS,” *Janes Space Directory Eleventh Edition 1995-96* (xxxxxxx), xxx; Clarence A. Robinson, Jr., “BMD Homing Interceptor Destroys Reentry Vehicle,” *Aviation Week & Space Technology*, 18 June 1984, 19-20; “Defense Dept. Plans Next Test Firing of Air-Launched Asat System,” *Aviation Week & Space Technology*, 23 September 1985, 20-21; “Tapes Studied for Clues in HBO Interference,” *Aviation Week & Space Technology*, 5 May 1986, 28; Craig Covault, “SDI Delta Space Experiment To Aid Kill-Vehicle Design,” *Aviation Week & Space Technology*, 15 September 1986, xxx; John Donnelly, “Laser of 30 Watts Blinded Satellite 300 Miles High,” *Early Bird*, 8 December 1997, 8; Nicholas L. Johnson, *Soviet Space Programs 1980-1985* (San Diego, CA: 1987), 137-142; William E. Burrows, *Deep Black: Space Espionage and National Security* (New York: Random House, 1986), 278; Jack Raymond, “Theory Disputed: Tests Appear to Bar ‘Umbrella’ to Halt Enemy Missiles,” *New York Times*, 20 Mar 1959, 1; Franklin A. Long, Donald Hafner, and Jeffrey Boutwell, editors, *Weapons in Space* (New York: W. W. Norton & Company, 1986), 22-23; Colonel-General Victor Smirnov, “Space Missile Defense Forces: Yesterday, Today, Tomorrow,” *Military Parade*, 1996, On-line, Internet, 31 March 1998, available from <http://www.milparade.ru/16/72-73.htm>.

Observations on the General Perception of Space Activities

The degree to which any individual space event is known largely depends on how well publicized it was: events given significant attention in the media are much more

likely to be known to a wide audience than those events which received little attention in print, on the radio, or on TV. The civil/commercial space events would naturally have more likelihood of being publicized because they were not classified and were, in fact, desirous of publicity to help improve their chances of continued funding. The military/intelligence space events, on the other hand, would be expected to have received somewhat less publicity because of their classified nature and desire for a generally low profile, given the “peaceful uses of space” policy that the U.S. government openly advocated. The end result of this would be a public perception that space was primarily used for civil/commercial endeavors and that military/intelligence activities were much less prevalent. The fact that U.S./U.S.S.R. military/intelligence space activities have actually had a larger number of launches than civil/commercial activities would likely come as a surprise to most of the American public.⁴²

During research for this history section of the paper, the author reviewed several sources on space history, including books, newspapers, periodicals, and Internet sources. This research revealed that the expectation of civil/commercial space activities having had more publicity than military/intelligence activities was indeed valid. The amount of published information available on civil/commercial space activities, especially the U.S. and Soviet/Russian manned space programs, was far greater than that for the military/intelligence space programs. Only on the subject of the Strategic Defense Initiative (SDI), which occurred more than half-way through the space age, did the amount of information approach that available for the manned space programs during the same years. However, since much of the SDI information was negative, discounting the feasibility of the early conceptions of the program, and these negative views were

unfortunately validated by the lack of visible progress in fielding any useful capabilities, it is uncertain how much the SDI debate changed the public's impression of what was actually going on in space. The debate certainly raised the public's consciousness about what might go on in space in the future, but the change in primary emphasis for the effort to defense against theater ballistic missiles, commensurate with the renaming of the OSD organization to the Ballistic Missile Defense Office (BMDO), undoubtedly created an impression that any major change to the current way of doing space business was still some time off in the future. Consequently, with the exception of the heyday of SDI in the mid/late 80's, it seems safe to say that the majority of information available to the public on space programs covered the civil/commercial space efforts, usually of the U.S. and U.S.S.R.

The foregoing discussion leads to two important observations: (1) senior leaders are much more likely to be aware of the civil/commercial uses of outer space than they are of the military/intelligence uses; and, consequently, (2) senior leaders are likely to be largely unaware of the extent of weaponization of space which has already occurred. These observations have great impact on the discussions of impediments to further weaponization of space, specifically regarding the policy aspects of further weaponization. This subject will therefore be revisited in Chapter 6.

Notes

¹ Jacob Neufeld, *Ballistic Missiles in the United States Air Force 1945-1960* (Washington, DC: Office of Air Force History, 1990), 169.

² David B. Guralnik, editor, *Webster's New World Dictionary of the American Language* (New York: William Collins + World Publishing Co., Inc., 1974), 313, 571, and 1148.

³ David N. Spires, *Beyond Horizons: A Half Century of Air Force Space Leadership* (Peterson AFB, Colorado: Air Force Space Command, 1997), 51-52. See also William

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E. Burrows, *Deep Black: Space Espionage and National Security* (New York: Random House, 1986), 92.

⁴ James Canan, *War in Space* (New York: Berkley Books, 1984), 4. See also Spires, *Beyond Horizons*, 51-52.

⁵ Neufeld, *Ballistic Missiles*, 169-70. See also *History of Space Exploration*, 1997, n.p.; on-line, Internet, 24 Nov 1997, available from <http://nauts.com/histpace/histpace.html>.

⁶ Allen Thompson, *Iraqi ASAT Gluegun*, 1995, n.p., and *Chinese ASAT and Rates of Change*, 1995, n.p., both on-line, Internet, 19 December 1997, available on http://www.fas.org/spp/military/program/asat/at_950925.htm.

⁷ Peter D. Zimmerman, "The Uses of SPOT for Intelligence Collection," *Commercial Observation Satellites and International Security* (London: The MacMillan Press LTD., 1990), 76-77. See also Michael Krepon, "The New Heirarchy is Space," *Commercial Observation Satellites and International Security* (London: The MacMillan Press LTD., 1990), 22.

⁸ Kevin C. Ruffner, ed., *CORONA: America's First Satellite Program* (Washington, DC: History Staff, Center for the Study of Intelligence, Central Intelligence Agency, 1995), 3.

⁹ Ruffner, ed., *CORONA*, 3. See also Neufeld, *Ballistic Missiles*, 170-171.

¹⁰ Ruffner, ed., *CORONA*, 22-24.

¹¹ *Ibid.*, 38.

¹² *Ibid.*, 49.

¹³ National Air and Space Museum, "Space Race", 1997, n.p., on-line, Internet, 12 Dec 97, available on <http://www.nasm.edu/GALLERIES/GAL114/SpaceRace/sec440/sec440.htm>.

¹⁴ Spires, *Beyond Horizons*, 50 and 90-91.

¹⁵ *Ibid.*, 89.

¹⁶ Paul Stares, "U.S. and Soviet Military Space Programs: A Comparative Assessment," *Weapons in Space* (New York: W.W. Norton & Company, 1986), 130. See also Harry Waldron, *Celebrating Our Past: The Earliest Air Force Satellite Programs*, 1997, 1-2, and *SMC Remembers The Vela Program*, 1997, 1; both on-line, Internet, 12 December 1997, available on <http://www.laafb.af.mil.past.htm>. Additional references can be found in Spires, *Beyond Horizons*, 138 and 147.

¹⁷ Major Roger C. Hunter, *A US ASAT Policy for a Multipolar World* (Maxwell AFB, Alabama: School of Advanced Airpower Studies, 1992), 18.

¹⁸ Hanson W. Baldwin, "3 Devices Fired: Explorer Also Helped Gain Knowledge of Magnetic Field," *New York Times*, 19 Mar 1959, 1. See also Jack Raymond, "Theory Disputed: Tests Appear to Bar 'Umbrella' to Halt Enemy Missiles," *New York Times*, 20 Mar 1959, 1.

¹⁹ Raymond, "Theory Disputed", 1.

²⁰ Jack Raymond, "B-47 Launches Anti-Satellite Missile," *New York Times*, 14 Oct 1959, 1. See also "ALBM Comes Close to Satellite Path," *Aviation Week and Space Technology*, 19 Oct 1959, 34.

²¹ Hunter, *A US ASAT Policy*, 18-22.

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²² Uri Ra'anan and Robert Pfaltzgraff, editors, *International Security Dimensions of Space* (Camden, Connecticut: The Shoe String Press, Inc., 1984), 297.

²³ Franklin A. Long, Donald Hafner, and Jeffrey Boutwell, editors, *Weapons in Space* (New York: W. W. Norton & Company, 1986), 22-23.

²⁴ Spires, *Beyond Horizons*, 188.

²⁵ Burrows, *Deep Black*, 277-278.

²⁶ Spires, *Beyond Horizons*, 188.

²⁷ Burrows, *Deep Black*, 278.

²⁸ Spires, *Beyond Horizons*, 188.

²⁹ "Year of Decision for ASAT Program," *Science* Vol. 236 (19 June 1987): 1512-1513. See also Nicholas L. Johnson, *Soviet Space Programs 1980-1985* (San Diego, CA: 1987), 137-142.

³⁰ *Soviet Military Power* (Washington, D.C.: U.S. Printing Office, 1981), 68. See also every other edition of *Soviet Military Power*: in 1983 on p. 65; in 1984 on p. 34; in 1985 on p. 55; in 1986 on p. 41; in 1987 on p. 45; in 1988 on p. 65; in 1989 on p. 55; and in 1990 on p. 60.

³¹ The author served as the Space Control Program Element Manager (PEM) in SAF/AQS in 1988-89 and was responsible for the termination activities associated with the F-15 launched Miniature Homing Vehicle (MHV) ASAT program.

³² William J. Broad, "Military is Hoping to Test-Fire Laser Against Satellite," *New York Times*, 1 September 1997; on-line, Internet, Nov 1997, available from <http://www.nytimes.com>.

³³ *Soviet Military Power* (Washington, DC: U.S. Government Printing Office, 1986, 1987, 1988, 1989, 1990) 35; 55; 51; 51; 65; 55; and 60-61, respectively, for each publication year listed.

³⁴ *Soviet Military Power* (Washington, DC: U.S. Government Printing Office, 1986), 46. See also Johnson, *Soviet Space Programs*, 137-142.

³⁵ *Soviet Military Power* (Washington, DC: U.S. Government Printing Office, 1985), 45.

³⁶ Craig Covault, "SDI Delta Space Experiment to Aid Kill-Vehicle Design," *Aviation Week & Space Technology*, 15 September 1986,.

³⁷ Alexander Flax, "Ballistic Missile Defense: Concepts and History," *Weapons in Space* (New York: W. W. Norton & Company, 1986), 34-9.

³⁸ Canan, *War in Space*, 34.

³⁹ While the Space Control Program Element Monitor (PEM) in SAF/AQS in 1988-89, the author had to orchestrate the response to a Congressional question on the possibility of using a U.S. ICBM or SLBM as a contingency ASAT weapon. The gist of the response was that it was theoretically possible to do this, but the practical problems were extremely stressing and the potential adverse consequences of using a nuclear weapon to destroy a satellite were many and serious.

⁴⁰ Allen Thompson, *Chinese ASAT and Rates of Change*, 1995, n.p., on-line, Internet, 19 December 1997, available at http://www.fas.org/spp/military/program/asat/at_951231.htm.

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⁴¹ John Donnelly, "Laser of 30 Watts Blinded Satellite 300 Miles High," *Early Bird*, 8 December 1997, 8. See also Bill Gertz, "U.S. Weighs sharing satellite laser test data," *The Washington Times*, 2 January 1998, 2-3, On-line, Internet, 31 March 1998, available from http://www.fas.org/spp/military/program/asat/wt_981002.htm.

⁴² Charles S. Sheldon II, *United States and Soviet Progress in Space: Summary Data Through 1979 and a Forward Look* (Washington, DC: Congressional Research Service, 23 January 1978), CRS-49.

Chapter 3

Future U.S. Space Capabilities

Victory smiles upon those who anticipate the changes in the character of war, not upon those who wait to adapt themselves after the changes occur.

—Air Marshall Giulio Douhet

There is widespread recognition that warfare in the 21st Century will be different than it has been in the 20th. Many studies have been conducted to try to envision what the future form of warfare will be like. All these studies see space systems playing a major role in the nation's future military force structure. The roles that space systems are expected to play include those being done now, primarily falling under the heading of force enhancement, as well as roles in space control and force application. The top-level expectations for space systems are established by discussions of future capabilities by Joint Vision 2010, the Quadrennial Defense Review, and the National Defense Panel. Specific space capabilities are proposed in several key AF future forces studies, namely the AF Scientific Advisory Board's (SAB's) *New World Vistas: Air and Space Power for the 21st Century*, the Air University's 2025 study, and the Center for Strategic and International Studies' (CSIS') *Air and Space Power in the New Millennium*. The top-level expectations for space weapons, as well as any specific capabilities that might be identified, are summarized below. These expectations, together with the background

information of Chapter 2, form the basis of the rationale for modifying the impediments currently obstructing progress on space weaponization that will be made in Chapter 6.

Joint Reviews of Future U.S. Defense Capabilities

Each of the three major joint reviews of the defense capabilities needed by the U.S. in the future expects a major contribution from space-based systems. All recently completed, the three reviews provide a useful starting point for envisioning where space weapons must go to provide the defense capabilities the U.S. needs in the coming decades.

Joint Vision 2010

Overview. *Joint Vision 2010 (JV 2010)* is DoD's roadmap for the evolution of current military forces to those required for success in the 21st Century. The Chairman, Joint Chiefs of Staff (CJCS) determined that U.S. military forces must "develop four operational concepts: dominant maneuver, precision engagement, full dimensional protection, and focused logistics."¹ Together, these four concepts will allow the U.S. to achieve Full Spectrum Dominance, which is the "key characteristic we seek for our Armed Forces in the 21st Century."² *JV 2010* envisions achieving Full Spectrum Dominance by taking advantage of several important technology trends, which lead to long-range precision weapon capabilities, a greater variety of weapon effects, and the ability to mass weapon effects without massing forces.³ While not explicitly calling for space weapons (or any other particular weapons, for that matter), *JV 2010* does call for capabilities that could be provided by space weapons.

Space weapons have the potential to incorporate the three desirable weapon characteristics – long-range precision, variety of effects, and massed effects with dispersed forces – while contributing to Full-Dimensional Protection, Precision Engagement, and Dominant Maneuver. Space weapons would do this by performing both space control and force application functions. Space control activities would support both Full-Dimensional Protection and Precision Engagement, while force application activities would support both of these also as well as Dominant Maneuver.

Full-Dimensional Protection. Full-Dimensional Protection entails “control of the battlespace to ensure our forces can maintain freedom of action during deployment, maneuver and engagement, while providing multi-layered defenses for our forces and facilities at all levels.”⁴ Space weapons, performing the space control function, would be a key element of Full-Dimensional Protection by helping ensure the safety of U.S. and allied space-based forces (from enemy attack) as well as ground-based friendly forces from enemy intelligence/surveillance/reconnaissance (ISR) observation.⁵ And, eventually, space weapons would be needed to protect U.S. forces from enemy space weapons. In addition, space weapons would contribute to Full-Dimensional Protection by doing force application against enemy forces, specifically by performing the ballistic missile defense mission.

Precision Engagement. Space weapons also provide a capability to do Precision Engagement, which is expected to be accomplished by “a system of systems that enables our forces to locate the objective or target, provide responsive command and control, generate the desired effect, assess our level of success, and retain the flexibility to reengage with precision when required.”⁶ Space weapons have the potential to deliver

highly accurate, controllable force, with virtually no warning, against a target located anywhere within the vicinity of the Earth. Space weapons would perform precision engagement against targets to do both space control missions (e.g., precisely engaging enemy satellites) and force application missions (e.g., precisely engaging a host of potential space- or earth-located targets). These precise attacks could be used in support of Full-Dimensional Protection, or to achieve other U.S. objectives, such as destroying an adversary's command and control system.

Dominant Maneuver. Space weapons could be used to achieve Dominant Maneuver. Dominant Maneuver involves “the multidimensional application of information, engagement, and mobility capabilities to position and employ widely dispersed joint air, land, sea, and space forces to accomplish the assigned operational tasks.”⁷ Space weapons can help the U.S. achieve dominant maneuver by providing capabilities that are virtually omni-present yet dispersed, and that have the ability to focus effects decisively at a point in time and space of DoD's choosing. Space weapons, doing force application, can provide the long range, lethal fire, particularly deep into denied territory, that may be vital to achieving an objective for a U.S. operation.

Focused Logistics. Finally, an additional comment about the fourth key operational concept in *JV 2010*: Focused Logistics. Space weapons do not directly contribute to accomplishing this concept, but the use of space weapons to perform the other three *JV 2010* concepts could result in less equipment needing to be sent to a theater in time of crisis. This eases the immediate burden on the logistics system, since, in effect, space weapons have been “pre-positioned” where they are needed before the conflict.

Quadrennial Defense Review

Overview. The Quadrennial Defense Review (QDR) was conducted as a DoD-wide effort, with the Office of the Secretary of Defense (OSD), Joint Chiefs of Staff (JCS), Services, and combatant command Commanders in Chief (CINCs) all contributing.⁸ Signed out by the Secretary of Defense (SecDef) in May 1997, the report used *JV 2010* as its guide for focusing efforts to remake the U.S. military into a new, more effective 21st Century fighting force.⁹ The QDR envisioned the threat environment that the U.S. would face between 1997 and 2015, then developed a strategy to deal with that threat, consistent with the current National Military Strategy of Shape-Respond-Prepare.¹⁰ Finally, the modernization of existing U.S. forces was driven by the anticipated threat environment and the strategy to deal with it, resulting in the force structure decisions stated in the QDR; the QDR looks to the individual Services to further explore how their forces need to evolve in the long-term.

Regarding space weapons, the QDR does not specifically call for them, but certainly describes a Global Security Environment and a Defense Strategy within which space weapons could be major contributors. The two sections below cite relevant sections of the QDR, identifying the areas in which space weapons could provide needed capability.

Global Security Environment. In the “The Global Security Environment” section, the QDR identifies specific future security concerns. Within this list are “the spread of nuclear, biological, and chemical (NBC) weapons and their means of delivery” as well as “capabilities to access, or deny access to, space.”¹¹ Later in the section, the report notes the U.S. enjoys a “significant advantage” over potential adversaries in a variety of capabilities, including “space-based assets,” but also warned that these advantages “could also involve inherent vulnerabilities” if the U.S. did not take proper precautions.¹² This

section, then, identifies the need for U.S. capability to protect its space assets, as well as to be able to negate the space assets of potential adversaries. It also identifies the need for a ballistic missile defense capability. Both these needs, which neatly fall within the space control and force application functions of space weapons, suggest great potential utility for U.S. space weapons.

Defense Strategy. In the “Defense Strategy” section, the QDR identifies several U.S. vital national interests, including “ensuring freedom of the seas and security of international sea lines of communication, airways, and space.”¹³ To help achieve this, the report notes that the ability to deter aggression and coercion rests, among several factors, on the U.S. having “conventional warfighting capabilities that are credible across the full spectrum of military operations.”¹⁴ These capabilities need to be “strategically stationed” or “rapidly deployable,” so they have the ability to react quickly to any contingency.¹⁵ The report states that responses could include “limited strikes,” which would need to be conducted “in any environment, including one in which an adversary uses asymmetric means, such as NBC weapons.”¹⁶ The report also identifies three requirements associated with the strategy of fighting and winning two major regional contingencies: the first is to be “able to rapidly defeat initial enemy advances short of their objectives in two theaters in close succession, one followed almost immediately by another.”¹⁷ The other two requirements call for forces able to operate against asymmetric threats, such as NBC weapons, and the ability to “transition to fighting major theater wars from a posture of global engagement.”¹⁸ The QDR plans on achieving the required military capabilities through, in part, using the new technologies emerging from the Revolution in Military Affairs (RMA). Specifically, the QDR plans to harness “new technologies to give U.S.

forces greater military capabilities through advanced concepts, doctrine, and organizations so that they can dominate any future battlefield.”¹⁹ The approach to harnessing the RMA includes pursuing “Service visions of warfare for 2010 and beyond” as well as research and development efforts in promising technologies, including appropriate experiments and tests.²⁰ Finally, near the end of the “Defense Strategy” section, the QDR identifies critical enablers for the strategy. One of the five listed critical enablers follows.

The United States must retain superiority in space. Global intelligence collection, navigation support, meteorological forecasting, and communications rely on space-based assets. To maintain our current advantage in space even as more users develop capabilities and access, we must focus sufficient intelligence efforts on monitoring foreign use of space-based assets as well as develop the capabilities required to protect our systems and prevent hostile use of space by an adversary.²¹

The defense strategy described above creates an environment in which space weapons could be very useful. Defending U.S. and allied use of space and denying the use of space to an enemy can be done without space weapons, but having space weapons would clearly provide other – likely more effective and efficient – options to the U.S. during a crisis or conflict. Likewise, new technologies emerging from the RMA could be harnessed only in Earth-based weapons to provide the capabilities called for in the strategy, but space weapons again offer attractive options to the U.S. With their timely global access and relative insensitivity to many of the asymmetric threats that an enemy might employ against U.S. forces, space-based weapons could provide uniquely flexible ways to achieve the nation’s objectives. And switching forces from one theater to another to respond to a second crisis is easy for space-based weapons: provided the space weapon constellations have been sized correctly, the space weapons would be “present” in both theaters automatically, and on a virtually continuous basis. This

provides the U.S. capabilities that could immediately respond to a crisis anywhere, bringing effective firepower to bear early enough to help achieve a decisive halt before too much damage is done. For example, while space weapons might not be the best option to destroy large numbers of mobile hard-targets (i.e., tanks), they might very well be able to destroy a substantial number of soft gasoline tanker trucks, depriving an enemy advance of the vital fuel necessary to continue the attack. Other targets, such as forward command centers, could be located by space-based and other sensors, and immediately subjected to space weapon attacks, further disrupting advances.

National Defense Panel (NDP)

Overview. The National Defense Panel (NDP) was tasked by law to provide an independent assessment of the QDR as well as an alternate force structure assessment.²² The NDP's report, *Transforming Defense: National Security in the 21st Century*, focused somewhat further out than the QDR, looking at forces necessary for the 2010-2020 period versus the QDR's focus on 1997 to 2015. Consequently, the NDP recommended more revolutionary changes to force structure, starting immediately, in order to better prepare for longer-term, emerging threats. Like the QDR, the NDP report does not identify a specific need for space weapons, but does describe an environment in which space weapons could certainly make a contribution. These contributions fall in two areas already discussed above: space control (protecting U.S. and allied space assets and denying an enemy the use of his space assets) and force application (with sub categories for ballistic missile defense and precision strike).

Space Control. The NDP noted the U.S. has a significant lead in space, but that this lead "will not go unchallenged."²³ Specifically, the NDP states "given the importance of

space-based capabilities to information operations, our ability to operate in space, support military activities from space, and deny adversaries the use of space will be key to our future military success.”²⁴ And, in the same section of the report, the NDP re-emphasizes the importance of space by noting “we must protect our space assets to include our commercial assets and deny our enemies the opportunity to gain military advantages through their use of space.”²⁵ Finally, in its strongest statement on the topic, the NDP says “we must take steps now to ensure we have the capability to deny our enemies the use of space.”²⁶ Space weapons are not required to protect U.S. and allied space assets, or to deny an enemy the use of their own space assets, but space weapons would provide options not possible with any other capabilities. Also, from a cost effectiveness standpoint, space weapons are potentially the clear favorites for some types of protection and negation activities.

Force Application – Missile Defense. The NDP notes that one key aspect of successful U.S. power projection is “defending key regional partners against enemy missile strikes.”²⁷ The NDP also identifies U.S. “Homeland Defense” as an area that will require more attention, including active defenses against Weapons of Mass destruction. While not calling for deployment of a national missile defense system yet, the NDP does propose doing the necessary research to be ready to deploy a missile defense system when a threat clearly emerges.²⁸ Space weapons offer effective means of doing national missile defense, and, given constellations are sized appropriately, would be able to help protect regional allies from some theater ballistic missile attacks also.

Force Application – Precision Strike. The NDP report, like the QDR, called for “greater mobility, precision, speed, stealth, and strike ranges while we sharply reduce our

logistics footprint.”²⁹ And aerospace capabilities are specifically encouraged to “ensure a proper mix of short- and long-range aerospace forces to enable optimal strike operations” and to “explore new approaches to long-range, precision delivery vehicles.”³⁰ However, the NDP report noted a difference between Service visions of where their forces should go in the future and the actual procurement activities the Service’s were pursuing.³¹ And, in addition to remedying this disconnect, the NDP called for more attention on experimentation, with the Services seeking ways to deal with emerging threats with new systems, concepts, and force structures.³² Unlike the QDR, the NDP does not propose a defense strategy for the future, but instead suggests the types of forces that might be needed to implement whatever strategy is developed to address expected threats at the time. The NDP identifies six key challenges which the military will have to be able to address in 2020: information attacks; use of weapons of mass destruction; space operations; absence of access to forward bases; deep inland operations; and mass population problems.³³ But power projection is still viewed as the premier U.S. military requirement, and the NDP says this will have to be done “more rapidly, absent forward access, with smaller units and footprints, [and] with greater lethality.”³⁴ To do this, the NDP believes that “the cutting-edge ability to accomplish U.S. national security objectives will come from new approaches and thinking about power projection and asymmetric warfare capabilities.”³⁵ And, in order to gain control of an evolving crisis, the NDP suggests the U.S. be able to accomplish “the simultaneous execution of a range of operations – conducting extended-range precision strikes, seizing control of space and information superiority,...and providing missile defense.”³⁶

Combining the aforementioned ideas, the prospects for space weapons are encouraging. Space weapons can provide greater precision and strike ranges, are inherently mobile in their globe-spanning orbits, have small logistics footprints in theater (i.e., perhaps only a workstation in an operations center that coordinates with CONUS-based weapon operators), and can attack with relatively great speed (if constellations are sized appropriately). Space weapons, with their tightly controlled communications systems, should be fairly well protected against information warfare attacks (and could be one means of accomplishing information warfare attacks in theater against an enemy). Space weapons could be useful dealing with weapons of mass destruction (when flown on ballistic missiles), could operate without forward bases, and could accomplish deep inland attack operations. And, in keeping with the NDP's encouragement for Services to pursue their visions, the evolution of the Air Force to a space and air force would provide the perfect growth path for space weapons to be incorporated into DOD's force structure.

Summary of Joint Studies

Viewed together, the three joint documents – *JV 2010*, the QDR, and the NDP report - are consistent in their view that space will be important to future U.S. military operations. They all see the need to protect U.S. and allied use of space, and to be able to deny an enemy the use of space at the appropriate time. The three documents also see the need for protection against ballistic missile attacks, though when such a system would need to be deployed is uncertain. Finally, the three reports see a future security environment in which long-range, time-responsive, precision strike capability is very valuable; the less this strike capability depends on in-theater logistics, forward bases, or mobility assets, the better. While none of the documents calls for space weapons

specifically, the capabilities that the documents seek could clearly be provided by space weapons. And all the documents emphasize that the U.S. must take advantage of its technological prowess to develop asymmetric capabilities for future warfighting. Finally, the QDR and NDP reports specifically look to the Services to pursue their individual visions in such a way as to evolve their forces effectively in the long-term to protect the U.S. qualitative edge over adversaries.

Space Systems and the Major Air Force Future Studies

With its expressed intention to evolve from an Air Force to an Air and Space Force, then eventually to a Space and Air Force, the U.S. Air Force is the most space-oriented of the Services. Consistent with this vision, space systems are key elements of the force structures envisioned by several major AF-sponsored future studies. These studies are the AF Scientific Advisory Board's (SAB's) *New World Vistas: Air and Space Power for the 21st Century*, the Air University's *2025*, and the Center for Strategic and International Studies' (CSIS') *Air and Space Power in the New Millennium*.

New World Vistas

The Secretary of the Air Force (SecAF) and the Chief of Staff of the Air Force (CSAF) together directed the AF SAB to perform “a truly independent, futuristic view of how the exponential rate of technological change will shape the 21st Century Air Force.”³⁷ Specifically, the SecAF and CSAF tasked the AF SAB to perform a one year study, *New World Vistas*, which would “offer a ten year technological forecast” covering seven key areas of interest to the AF; “space technology” was listed within the first of the seven areas.³⁸ The AF SAB's resulting *New World Vistas* study, in the first paragraph of

its Foreward, makes a tone-setting prediction – “Further, the domain of conflict is moving from earth into space and even into cyberspace.”³⁹ However, even with this observation, the study intentionally excluded two topics which have significant connections to space weapons: National Missile Defense and Nuclear Weapon Technology.⁴⁰ Nevertheless, *New World Vistas* still made several important recommendations regarding space weapons and the technologies that would enable them.

In the summary discussion of the Future Force, *New World Vistas* states “the future force will, eventually, contain space, ground, and airborne weapons that can project photon energy, kinetic energy, and information against space and ground assets.”⁴¹ Expanding on this projection in the Capabilities and Technologies section, *New World Vistas* discusses both Space Control and Force Projection from Space. Regarding Space Control, *NWV* says

Control of space will become essential during the next decade. We will depend on satellites to provide Global Awareness and Dynamic Control for our Forces, and commercial services may be a threat to those Forces. As commercial involvement of US companies in space increases, the United States may be called upon to protect nonmilitary space assets from attack by terrorists or a rogue nation. We should be prepared to execute three missions:

Protect US military space assets and launch capabilities.

Deny the use of threat assets.

Protect allied, non military space assets.⁴²

Regarding the technology best suited to perform space control attacks, *NWV* states “therefore, we recommend ground-based Directed Energy weapons to attack threats in space.”⁴³

For Force Projection from Space, *NWV* notes “there are political issues related to the projection of power from space, but we treat only the technological ones.”⁴⁴ After

reviewing both kinetic energy and directed energy weapon options, *NWV* recommends that ICBMs should be used to deliver kinetic energy weapons (versus space-based weapons) and notes that ground-based lasers, with space-based mirrors, are more viable than space-based lasers to deliver directed energy.⁴⁵

The *NWV* report sees space weapons in the future for the U.S. – and not just as assets the U.S. can use, but also as threats against which the U.S. will need to protect itself. And, while several phenomenologies could be used in space weapons, the *NWV* indicated that directed energy technology seemed the most viable given its growing maturity, flexibility, and other advantages over competing contenders.

2025

The Chief of Staff of the Air Force (CSAF) tasked the Air University to conduct a study that would forecast what the Air Force should be like 30 years from the tasking date in 1995.⁴⁶ The resulting study, called *2025*, did extensive work envisioning the various potential world situations in the future (alternative futures), determining the military capabilities which would be most useful in those situations, and the technologies that would support those capabilities.

Space weapons emerged as highly effective capabilities in the analysis that was conducted, serving as the basis for three of the top ten systems (with a fourth having weapon capability as well as transport capability).⁴⁷ The three high leverage space weapon systems - Global Area Strike System, Space-Based High Energy Laser System, and Solar-Powered High Energy Laser System – shared technology and had somewhat overlapping capabilities. In fact, not only were space-based lasers the basis of two of the systems, but they were also one of the three prime components of the Global Area Strike

System also. The other two components of the Global Area Strike System were a kinetic energy weapon (KEW) and a transatmospheric vehicle (TAV). And the TAV, by itself, was the fourth high leverage space system identified in the top ten, with a primary mission of space support and global reach, but with the ability to also serve as a weapon deployment platform.⁴⁸

2025 recognizes the military significance of space, observing “that space is the ultimate high ground.”⁴⁹ It goes on to state “the fact that others will be attempting to utilize space for their own purposes and to compete, peacefully and militarily, from and in space means that it must be viewed as an important potential battlespace of the future.”⁵⁰ As a consequence, one of 2025’s key conclusions is that “the USAF must pursue the exploitation of information and space with the same fervor with which it has mastered atmospheric flight.”⁵¹ 2025 then goes on to discuss how space weapons would perform both counterspace and space strike missions.⁵² The counterspace missions are both offensive, using weapons such as “parasite microsatellites (robo-bugs), transatmospheric vehicles, and a ground-based laser system,” and defensive, using “miniature satellite body guards to protect high value assets.”⁵³ The space strike missions include interdiction, strategic attack, and counterair; space weapons include “a continental US-based laser system which bounces high energy beams of a constellation of space-based mirrors” and “a transatmospheric vehicle ...as a weapons platform for kinetic energy projectiles, directed energy weapons, and manned strike.”⁵⁴

Air and Space Power in the New Millenium

The CSIS’ *Air and Space Power in the New Millenium* report has the nearest-term focus of the three Air Force studies cited and is intended to help the Administration and

Congress formulate a new defense strategy for the 21st Century.⁵⁵ The study introduces a new paradigm for warfare that focuses on the “third dimension” and emphasizes the attributes of (primarily) air power.⁵⁶ Consequently, it has very little discussion of space weapons. Most of this discussion focuses on the defensive and offensive aspects of space control. However, there is an explicit acknowledgement that space weapons will be an important part of the AF’s future.

Echoing AF Doctrine Document 1, the CSIS report discusses the need to attain space superiority, which requires offensive counter space and defensive counter space capabilities. Offensive counter space activities, much like the negation part of space control, require “missions conducted against an adversary’s space-based systems.”⁵⁷ Defensive counter space activities, essentially a combination of the protection part of space control and USSPACECOM’s Worldwide Missile Defense, require “missions that defend against systems operating in space, including missions that protect against cruise and theater missile defense [sic] – e.g., ballistic missile defense.”⁵⁸ The report notes the technical and international political challenges associated with performing these missions. It warns “thus, assuring space superiority in battles of the future will require whole new technologies and concepts and a diplomatic framework that will protect U.S. and allied systems while selectively denying the capabilities of commercial and third-nation systems to the enemy.”⁵⁹

The only specific reference the report makes on the force application from space question (USSPACECOM’s Worldwide Precision Strike mission area) occurs in a more sweeping prediction of where the AF most go in space. The report says:

Space control and operations in and from space will play an increasingly prominent role for a military that seeks to exploit the potential of modern

air and space power. The U.S. Air Force's long-range plan envisions the evolution of that institution from an air and space force to a space and air force. The growing importance of space-based assets to air and space superiority means that those assets will become targets of hostile action, requiring that they be defended. *The logic of the new paradigm suggests that there will also be a future need to deploy weapons in space that are capable of taking advantage of information superiority to more rapidly secure air dominance and to increase the tempo of precision strikes.*⁶⁰
[emphasis added]

Summary of AF Studies

The three AF-sponsored future studies all envision combat in space in the future. They all point to the need for the U.S. to defend its space-based infrastructure, noting it is becoming an increasingly lucrative target for potential adversaries. Beyond protecting U.S. and allied/friendly space systems, the studies also state the need for the U.S. to be able to deny space to an adversary, including attacks upon the space-based segments of any systems providing data or services to that adversary. *NWV and 2025* explicitly recommend the development of specific space weapons, while *Air and Space Power* notes that logic dictates the eventual development of space weapons by the Air Force. Given the more near term focus of *Air and Space Power* versus *NWV* and *2025* as well as the difference in purpose between the studies, this slight disconnect is understandable. Consequently, there emerges a consistent vision that suggests that sometime between the start of the next century and the year 2007 the AF should start development of space weapons, and these should become major elements of U.S. force projection capability by the year 2025.

Notes

¹ Gen. John M. Shalikashvili, *Joint Vision 2010* (Washington, DC: 1997), 1.

² *Ibid.*, 2.

³ *Ibid.*, 11, 12, and 17.

Notes

⁴ Ibid., 22.

⁵ Ibid., 23.

⁶ Ibid., 21.

⁷ Ibid., 20.

⁸ Hon. William S. Cohen, "Design, Approach, and Implementation of the Quadrennial Defense Review," *Report of the Quadrennial Defense Review* (Washington, D.C.: May 1997), 1, available on the internet 3 December 1997 at <http://www.defenselink.mil/pubs/qdr/sec1.html>.

⁹ Hon. William S. Cohen, "The Secretary's Message," *Report of the Quadrennial Defense Review* (Washington, D.C.: May 1997), 2, available on the internet 3 December 1997 at <http://www.defenselink.mil/pubs/qdr/msg.html>.

¹⁰ Hon. William S. Cohen, "Design, Approach, and Implementation of the Quadrennial Defense Review," *Report of the Quadrennial Defense Review* (Washington, D.C.: May 1997), 2, available on the internet 3 December 1997 at <http://www.defenselink.mil/pubs/qdr/sec1.html>.

¹¹ Hon. William S. Cohen, "The Global Security Environment," *Report of the Quadrennial Defense Review* (Washington, D.C.: May 1997), 2, available on the internet 3 December 1997 at <http://www.defenselink.mil/pubs/qdr/sec2.html>.

¹² Ibid., 3.

¹³ Hon. William S. Cohen, "Defense Strategy," *Report of the Quadrennial Defense Review* (Washington, D.C.: May 1997), 3, available on the internet 3 December 1997 at <http://www.defenselink.mil/pubs/qdr/sec3.html>.

¹⁴ Ibid., 5.

¹⁵ Ibid., 5.

¹⁶ Ibid., 7.

¹⁷ Ibid., 9.

¹⁸ Ibid., 9.

¹⁹ Ibid., 11.

²⁰ Ibid., 12.

²¹ Ibid., 15.

²² *National Defense Authorization Act of 1996, Public Law 104-201* (Washington, D.C.: 1995), 4; on-line, internet, 3 December 1997 at http://www.defenselink.mil/topstory/quad_leg.html.

²³ Phillip A. Odeen et al, *Transforming Defense: National Security in the 21st Century*, 1997, iii, on-line; Internet, 3 December 1997, available from <http://www.defenselink.mil/topstory/ndp.html>.

²⁴ Ibid., 14.

²⁵ Ibid., 14.

²⁶ Ibid., 39.

²⁷ Ibid., 35.

²⁸ Ibid., 26.

²⁹ Ibid., iii.

³⁰ Ibid., 48.

³¹ Ibid., iii.

Notes

- ³² Ibid., iv.
- ³³ Ibid., 21.
- ³⁴ Ibid., 33.
- ³⁵ Ibid., 33.
- ³⁶ Ibid., 35.
- ³⁷ Dr. Gene H. McCall and Maj. Gen. (ret.) John A. Corder, *New World Vistas: Air and Space Power for the 21st Century (Summary Volume)* (Washington, D.C.: Air Force Scientific Advisory Board, 1995), A-3.
- ³⁸ Ibid., A-3.
- ³⁹ Ibid., iii.
- ⁴⁰ Ibid., 4.
- ⁴¹ Ibid., 11.
- ⁴² Ibid., 46.
- ⁴³ Ibid., 46.
- ⁴⁴ Ibid., 47.
- ⁴⁵ Ibid., 46-47.
- ⁴⁶ 2025 Support Office, *2025 Executive Summary*, 1996, 6; on-line, Internet, 14 February 1998, available from <http://www.au.af.mil/au/2025/monographs/E-S/e-s.htm>.
- ⁴⁷ Ibid., 23-26.
- ⁴⁸ Ibid., 26.
- ⁴⁹ Ibid., 14.
- ⁵⁰ Ibid., 14.
- ⁵¹ Ibid., 15.
- ⁵² Ibid., 46 and 49.
- ⁵³ Ibid., 46.
- ⁵⁴ Ibid., 49.
- ⁵⁵ Daniel Goure and Christopher M. Szara, editors, *Air and Space Power in the New Millennium* (Washington, D.C.: Center for Strategic and International Studies, 1997), 1.
- ⁵⁶ Ibid., 27.
- ⁵⁷ Ibid., 92.
- ⁵⁸ Ibid., 92.
- ⁵⁹ Ibid., 19.
- ⁶⁰ Ibid., 42-43.

Chapter 4

Space Weapon Missions

Prior to determining what impediments interfere with DOD's ability to further weaponize space, it is useful to review the array of missions that could be performed by space weapons. Once these missions have been enumerated and logically grouped, creating a taxonomy of potential missions, then the impediments to pursuing these missions can be identified in the next chapter. Looking ahead, since impediments can relate to either the type of weapon used (e.g., a nuclear bomb) or the type of mission performed (e.g., the anti-ballistic missile mission), the taxonomy will be developed with this fact in mind.

The potential missions for space weapons fall into two broad areas associated historically with the functions of space control and force application. Both of these functions will be discussed below, individually, to establish the universe of potential things a space weapon could do.

Space Control Taxonomy

Introduction

Space Control capabilities (also known as Counterspace or Control of Space capabilities) are those capabilities used to protect the use of space by the U.S. and

associated allies as well as to deny the use of space to an adversary. Achieving Space Control is necessary to preserve the vast force multiplying effect that U.S. space assets provide to terrestrial military forces through intelligence/surveillance/reconnaissance (ISR), weather, missile launch warning, and precision navigation data, as well as communication capabilities. And, at the same time, Space Control denies an adversary this same militarily-useful space information from their own, third party, and U.S./allied space systems. Much like control of the sea, Space Control is likely to be contested more intensely in some areas and at some times than at others, since it is really only meaningful to have where either the U.S. or an adversary wants to accomplish some mission. To be useful, then, Space Control does not have to be achieved throughout all of outer space (i.e., it can be a local condition over a theater or smaller area) and it does not necessarily mean that an adversary has been totally denied the use of any space assets (though this is the highest possible goal, like air supremacy is the highest possible goal of counterair operations). Within this context, the component parts of Space Control can be reviewed to determine where space weapons may come into play.

Space Control is composed of four areas: space surveillance, protection, prevention, and negation.¹ Each will be included in the initial review of potential weapon applications to determine whether they need to be carried forward in the analysis.

Space Surveillance

Space Surveillance involves observing space with a variety of sensors to determine what is happening there. This includes tracking the locations of all objects in orbit around the globe, determining the missions of all the man-made satellites, and constantly understanding the operational status of these satellites. Specifically, the United States

Space Command (USSPACECOM) identifies six space surveillance tasks: “**Detect** – every launch and all objects; **Track** – all satellites (all sizes) over entire orbit, for entire orbit lifetime; **Characterize** – every launch, payload, owner, mission, capabilities, size, shape, orientation; **Classify** – threat; **Catalog/Monitor** – characterization data, orbital parameters for all satellites; and **Disseminate/Distribute** – products/data.”² Information on space objects can be gathered passively from simple collection of solar reflections from the satellite and emissions by the satellite (usually infrared or radio frequency energy). Information can also be gathered using active techniques, including radar and laser illumination of space objects to create specific return reflections. The sensor systems that perform these passive and active observation functions can be terrestrially-based (land, sea, or air) as well as space-based. While passive observation techniques are recognized as benign, there has been some concern about the potential impact of active techniques on the normal functioning of satellites: this touches on the weaponization issue.

While some active space surveillance techniques have a long history of use, others have had much less opportunity for application. Radar has been used to track satellites from the first days of the space age; initially, calculations were done to estimate the potential impacts on satellite instruments of this radar illumination. Now, radar illumination of satellites is so well known (and accepted), that new satellites are expected to be designed to withstand this illumination (i.e., new satellites are routinely illuminated without any special assessment of the likelihood that the radar might cause harm to the satellite).³ In effect, radar illumination is as much of the “natural” environment that satellites have to survive as vacuum, temperature extremes, or the Van Allen radiation

belts. However, the same is not true of laser illumination, which can also be used to track satellites. Because of the prevalence of optical instruments on satellites, and the potentially harmful effects that even low-power laser illumination could cause certain high-gain sensors, the U.S. currently follows a very conservative policy for DoD illumination of any man-made space objects.⁴ In addition to radars and lasers, there are other, more exotic active illumination sources that could be used to perform space surveillance functions, things such as particle beams (like a space-based version of the devices used to assess suspicious objects for airports). However, since the purpose of space surveillance is to understand something about the objects in orbit, not to change them (i.e., space surveillance intends to not cause any “harmful interference” to a satellite’s operation), all the aforementioned active techniques will be declared non-weapon applications when used for space surveillance. But these active illumination techniques will be reconsidered under the negation section, where they will be applied to satellites in such a manner that they would be expected to cause “harmful interference” to normal satellite operation.

Protection

Protection involves both passive and active techniques to prevent interruption of services provided by U.S. space systems. The ground- and space-based elements of satellites must be protected, along with the communication links connecting them. USSPACECOM identifies five tasks in this area: “**Detect and Report Threats/Attacks** – all threats and attacks to all U.S./Allied space systems; **Withstand and Defend** – all systems from all attacks, harden, maneuver, counter; **Reconstitute and Repair** – loss of vital space capabilities in days/hours; **Assess Mission Impact** – of space capabilities and

disseminate information in seconds.”⁵ Passive techniques to protect space systems include hardening various components of the satellite, placing components in positions that are screened from likely attack directions, making certain critical components redundant, and placing satellites into orbits more difficult to access from the ground (e.g., higher orbits, which place more demands on any ground-based weapon trying to perform an attack). The communication links between two or more spacecraft and between spacecraft and the ground are protected by encryption of the signals, various spread-spectrum and frequency hopping techniques, and selection of appropriate frequencies (e.g. those hard to detect or hard to jam from the earth). Active techniques to protect space systems include maneuvering away from a threat, deploying a shield or shutter, rotating the satellite away from a threat, disrupting the tracking or terminal guidance of a weapon, and shoot-back (i.e., protecting oneself by attacking the threat, such as with a small anti-ASAT missile carried on-board the satellite). The space weapon-related parts of the protection taxonomy are shown in Table 6 below; note that these all fall within the USSPACECOM-identified **Withstand and Defend** task, specifically as active responses to counter adversary attacks. It is also important to note that while these actions are all theoretically possible, most would be extremely difficult to use effectively because of the stringent timing and location requirements to successfully intercept an in-process attack. In other words, most of the following actions would not be practical to protect a specific satellite from a current attack, but they could be very useful in responsively removing an enemy’s ASAT capability before it can launch follow-on attacks. Of course, in some cases, these responsive actions could also be classified as negation or worldwide space strike actions, depending on the target’s location.

Recall now the definition of space weapons explained in Chapter 2. In keeping with both this definition and the yet-to-be-discussed impediments to further weaponization, the format of the taxonomy shown in the table below categorizes the specific space weapons by the mission they perform (in this case Protection), identifies the location of the weapon and the target (either earth or space), and identifies the type of weapon used in the attack (one of seven weapon phenomenology types). The seven weapon phenomenologies are: nuclear, kinetic energy, radio frequency (RF), high power microwave (HPM), laser, particle beam (PB), and information warfare (IW); see Appendix C for the rationale for selecting these phenomenologies. The categories in this taxonomy are repeated in all subsequent taxonomies and are key to later discussions in this paper.

Table 6. Space Weapons Used for Protection

Weapon Location	Target Location	Weapon Type	Example
Earth	Space	Nuclear	Ground-launched nuclear warhead detonates near enemy space-based laser ASAT
“	“	Kinetic	Ground-launched missile impacts enemy space-based laser ASAT
“	“	RF	Ground transmitter jams ASAT terminal guidance
“	“	HPM	Ground transmitter burns out ASAT electronics
“	“	Laser	Ground-based laser overheats ASAT sensor
“	“	Particle Beams	Not applicable
“	“	IW	Ground-based transmitter gains access to ASAT control system, then alters data/software
Space	Space	Nuclear	Nuclear “space mine” detonates near space-based ASAT
“	“	Kinetic	Defensive satellite intercepts in-coming ASAT with missile
“	“	RF	Target satellite-based transmitter jams ASAT terminal guidance
“	“	HPM	Defensive satellite transmitter burns out ASAT electronics

Weapon Location	Target Location	Weapon Type	Example
“	“	Laser	Space-based laser destroys ASAT sensor
“	“	Particle Beams	Space-based neutral particle beam burns out ASAT electronics
“	“	IW	Space-based transmitter gains access to ASAT control system, then alters data/software
Space	Earth	Nuclear	Satellite-borne nuclear weapon explodes above ASAT’s ground-station, killing it with focused radiation
“	“	Kinetic	Satellite-borne uranium rods de-orbit and destroy ASAT’s ground-station on impact
“	“	RF	Satellite-borne transmitter interferes with terminal guidance signals to ASAT
“	“	HPM	Satellite-borne transmitter burns out electronics in ASAT terminal guidance equipment on the ground
“	“	Laser	Space-based laser interferes with ASAT’s terminal guidance by warping ground communications antenna
“	“	Particle Beam	Not applicable
“	“	IW	Satellite-borne transmitter gains access to ASAT’s ground station control system, then alters data/software

There are two key assumptions embedded in the preceding table regarding particle beams and information warfare. First, particle beams are assessed to be unable to successfully make the air-to-vacuum or vacuum-to-air transition because of the reversal of propagation feasibility that occurs at the transition. Neutral particle beams propagate in a well-behaved way in vacuum, but get stripped of electrons in the atmosphere and then start bending according to the earth’s magnetic field lines. Charged particle beams can be made to propagate in a predictable manner for certain distances in the atmosphere, but then start bending according to the earth’s magnetic field lines when they reach vacuum. These behaviors make aiming either type of particle beam very problematic at any targets that are across the air/vacuum boundary from the weapon. Second, information warfare operators are likely to be on the ground and only use transmitters in

space to relay instructions to targets. This situation could be used to argue that there are no space-based versions of IW (disregarding the case of an astronaut in the shuttle, the international space station, or some future spaceplane acting as the IW operator, since this is unlikely in the foreseeable future). However, this paper sees an IW attack using a space-based transmitter as a relay in an analogous fashion to a ground-based laser using an orbiting mirror to direct the laser beam to a remote target: in both the IW and laser cases, the space-based element used to direct the attack against the remote target becomes itself a space weapon.

Prevention

Prevention involves activities to deny adversaries the use of information or services from U.S. or other nation space assets. USSPACECOM identifies three key tasks: “**Detect Use** – both unauthorized use and exploitation of U.S. and third party systems; **Assess Mission Impact** – to drive course of action development; **Timely and Flexible Reaction** – using all actions short of military response.”⁶ These activities are largely diplomatic for other nation satellites. For U.S. satellites, various prevention techniques are possible, including use of selective availability settings for navigation satellite data or turning off satellite broadcasts in the desired region of denial. Since USSPACECOM has defined this part of space control as using only non-military actions, there are no parts of protection that are applicable to the weaponization discussion.

Negation

Negation involves active operations to deny an adversary the use of space. USSPACECOM identifies three key tasks in this area: “**Target Identification** – complicated by a dynamic, networked environment; **Weaponizing** – must be precise to

achieve desired effects; and **Operations Cycle** – includes mission planning, execution, and combat assessment.”⁷ Negation operations can be described in terms of the five “D’s”: destroy, degrade, disrupt, deny, and deceive. The first two “D’s” – destroy and degrade – involve physical damage of the satellite, which is a permanent condition and usually results in a permanent effect on the satellite’s mission; “destroy” completely negates the satellite’s mission while “degrade” only partially negates the mission. The second two “D’s” – disrupt and deny – are temporary conditions which do not result in any permanent damage to the satellite’s mission and likely not to the physical satellite; “deny” is the total temporary negation of the satellite’s mission while “disrupt” is the partial temporary negation of the mission. The fifth “D” – deception – refers to actions that create false information within the satellite’s data (i.e., a form of Information Operations). The various “D’s” can be accomplished a number of ways, including application of energy by physical contact (kinetic energy attacks with missiles or particle beams) or by some type of electromagnetic radiation (including visible/infrared lasers, high power microwaves, or other radio frequency energy). The weapons that deliver this energy can be earth-based or space-based. A key point to note is that negation attacks can be made against any element of the satellite system: the space segment, the link segment, or the ground segment (where the ground segment could actually be located in the air, on or under the sea, or underground as well as on the ground). Attacks against the ground segment could be made by weapons in space, but could also be made by earth-based weapons. Consequently, not all negation activities involve space weapons, since neither the weapon nor the target of the weapon are in space. The space weapon-related sections of the negation taxonomy are shown in Table 7 below.

Table 7. Space Weapons Used for Negation

Weapon Location	Target Location	Weapon Type	Example
Earth	Space	Nuclear	Ground-launched nuclear warhead detonates near satellite
“	“	Kinetic	Ground-launched missile impacts satellite
“	“	RF	Ground transmitter jams satellite antenna
“	“	HPM	Ground transmitter burns out satellite electronics
“	“	Laser	Ground-based laser destroys satellite solar cells
“	“	Particle Beams	Not applicable
“	“	IW	Ground-based transmitter gains access to satellite or payload control system, then alters data/software
Space	Space	Nuclear	Nuclear “space mine” detonates near satellite
“	“	Kinetic	Co-orbital satellite collides with target satellite
“	“	RF	Satellite-based transmitter jams target satellite antenna
“	“	HPM	Satellite-based transmitter burns out target satellite electronics
“	“	Laser	Space-based laser destroys target satellite solar cells
“	“	Particle Beams	Space-based neutral particle beam burns out target satellite electronics
“	“	IW	Space-based transmitter gains access to satellite or payload control system, then alters data/software
Space	Earth	Nuclear	Satellite-borne nuclear weapon explodes above target ground-station, killing it with focused radiation
“	“	Kinetic	Satellite-borne uranium rods de-orbit and destroy ground-station on impact
“	“	RF	Satellite-borne transmitter jams signal to user equipment on the ground
“	“	HPM	Satellite-borne transmitter burns out electronics in user equipment on the ground
“	“	Laser	Space-based laser warps large communications antenna on ground with thermal loading
“	“	Particle Beam	Not applicable
“	“	IW	Satellite-borne transmitter gains access to ground station control system, then alters data/software

Force Application Taxonomy

The second mission area for potential use of space weapons is “force application” from space. This category encompasses any use of space weapons for other than space control (counterspace or control of space) purposes. USSPACECOM sees two categories for “force application” from space: Worldwide Missile Defense and Worldwide Precision Strikes. Worldwide Missile Defense has four key capabilities: Battle Management, On-Demand Missile Defense, Full Spectrum Engagement, and Combat Assessment.⁸ Worldwide Precision Strikes has five key capabilities: Precision Strike Battle Management, On-Demand Precision Strike, Flexible Strike (Fixed/Relocatable/Moving), Flexible Effects, and Combat Assessment.⁹ Worldwide Precision Strikes capabilities could perform traditional AF functions such as counterair, strategic attack, interdiction, and close air support (recognizing some of these functions would be particularly challenging from space). These functions could be performed by purely space-based weapons or by weapons with components based partly in the earth’s environment and partly in space (e.g., a ground-based laser with orbiting mirrors). Consistent with this paper’s definition, all systems that can do “force application” from space are space weapons; they are summarized in the table below.

Table 8. Space Weapons Used for Force Application

Weapon Location	Target Location	Weapon Type	Example
Worldwide Missile Defense			
Space	Space	Nuclear	Nuclear-driven x-ray laser ABM satellite attacks post boost vehicle (PBV) or re-entry vehicle (RV) in space
“	“	Kinetic	Space-based interceptor collides with PBV/RV
“	“	RF	Not applicable
“	“	HPM	Space-based transmitter burns out PBV/RV electronics

Weapon Location	Target Location	Weapon Type	Example
“	“	Laser	Not applicable
“	“	Particle Beam	Space-based particle beam burns out PBV/RV electronics
“	“	IW	Not applicable
Space	Earth	Nuclear	Space-based nuclear weapon explodes, destroying boosting missiles with focused radiation
“	“	Kinetic	Space-based interceptor collides with boosting missile
“	“	RF	Not applicable
“	“	HPM	Space-based transmitter burns out PBV/RV electronics
“	“	Laser	Space-based laser destroys boosting missile
“	“	Particle Beam	Not applicable
“	“	IW	Not applicable
Earth	Space	Nuclear	Earth-launched, nuclear armed interceptor explodes in space near in-bound RVs
“	“	Kinetic	Earth-launched interceptor collides with in-bound RV in space
“	“	RF	Not applicable
“	“	HPM	Ground-based transmitter burns out RV electronics in space
“	“	Laser	Not applicable
“	“	Particle Beam	Not applicable
“	“	IW	Not applicable
Worldwide Precision Strikes			
Space	Earth	Nuclear	Space-based nuke de-orbit onto target with zero warning
“	“	Kinetic	Space-based uranium rods de-orbit onto hard target, destroying it on impact
“	“	RF	Space-based transmitter jams enemy terrestrial communications
“	“	HPM	Space-based transmitter burns out enemy terrestrial electronics
“	“	Laser	Space-based laser distorts tracking radar of enemy integrated air defense system with thermal heating
“	“	Particle Beam	Not applicable
“	“	IW	Space-based transmitter gains access to enemy integrated air defense system and changes data/software

There are three key assumptions within the Worldwide Missile Defense section of the table that require explanation. First, PBVs and RVs are not viewed as vulnerable to either RF or IW attacks because they do not have accessible paths for these attacks to use once the ICBM has been launched (and an attack against the ICBM prior to launch is considered to be a Worldwide Precision Strike rather than Worldwide Missile Defense). Second, laser attacks are not seen as feasible against PBVs and RVs because of the thermal hardness of these targets; even Theater Ballistic Missile warheads, if they get into space, would have to be hardened to withstand re-entry. This does not mean that some future version of a space-based laser could not achieve the power levels necessary to destroy a hardened target, but it does reflect the opinion that achieving that power level is sufficiently far in the future that it does not need to be dealt with in the next 20 years. Third, as stated earlier, particle beams cannot make the vacuum-to-air/air-to-vacuum transition effectively, so they are not credited with any capability requiring this transition in either Worldwide Missile Defense or Worldwide Precision Strikes.

Summary of Space Missions of Interest

Combining the space control and force application taxonomies, and eliminating the “not applicable” weapon lines, produces a table showing all the elements pertinent to the question of weaponizing space (see Table 9 below). Only these items will be carried forward for analysis in the next chapter, where the two empty columns (on impediments and comments) will be completed. Note that, for the level of analysis done in this paper, it is possible to combine the Satellite Protection and Satellite Negation categories with no loss of insight into the issues.

Table 9. Combined Space Weapon Taxonomy

Weapon Location	Target Location	Weapon Type	Impediment	Comments
Satellite Protection and Negation				
Earth	Space	Nuclear		
“	“	Kinetic		
“	“	RF		
“	“	HPM		
“	“	Laser		
“	“	IW		
Space	Space	Nuclear		
“	“	Kinetic		
“	“	RF		
“	“	HPM		
“	“	Laser		
“	“	PB		
“	“	IW		
Space	Earth	Nuclear		
“	“	Kinetic		
“	“	RF		
“	“	HPM		
“	“	Laser		
“	“	IW		
Worldwide Missile Defense				
Earth	Space	Nuclear		
“	“	Kinetic		
“	“	HPM		
Space	Space	Nuclear		
“	“	Kinetic		
“	“	HPM		
“	“	PB		
Space	Earth	Nuclear		
“	“	Kinetic		
“	“	HPM		
“	“	Laser		
Worldwide Precision Strikes				
Space	Earth	Nuclear		
“	“	Kinetic		
“	“	RF		
“	“	HPM		
“	“	Laser		
“	“	IW		

Notes

¹ DoD Space Architect, *Space Control Architecture*, 1997, 3; on-line, Internet, 12 December 1997, available from <http://www.acq.osd.mil/space/architect/>

² USSPACECOM, *USSPACECOM Long Range Plan (Draft)*, 12 Dec 97, CoS-22.

³ While serving as the Space Control PEM in SAF/AQS from 1988-1990, the author had several discussions with Lincoln Lab and Space Command personnel on the functioning of the space surveillance network. Since several of the radars that track satellites do this only as a collateral mission – their primary mission being to look for incoming nuclear warheads – they operate continually in their assigned regions and illuminate anything that flies through it. Likewise, the Naval Space Command operates a “fence” of radio-frequency emitters across the southern U.S. which is continually on and illuminates everything that flies through it. Any low-earth orbit satellite must expect to be illuminated by these, as well as other space monitoring radars, on a frequent basis.

⁴ In 1996-97, the author served as the Phillips Laboratory point of contact for modification of the current DoD satellite laser illumination policy (often called the Foster Policy, after the Dr Foster, who signed it into being in 1970, while he was the Director of the Defense Research and Engineering office). As the POC, the author coordinated responses from various Phillips Lab offices and relayed them, through SAF/SX, to the DUSD(Space) office, which was reviewing the outdated policy for revision. The policy revision, still in draft, is intended to bring U.S. practices more in line with those (less conservative) practices of other nations in order to provide more opportunities for DoD research and development efforts.

⁵ USSPACECOM, *USSPACECOM Long Range Plan (Draft)*, 12 Dec 97, CoS-32

⁶ Ibid., CoS-43

⁷ Ibid., CoS-53

⁸ Ibid., GE-23-4

⁹ Ibid., GE-37-8

Chapter 5

Impediments to Further Space Weaponization

There are several impediments to further weaponization of space, covering a spectrum of issues. But perhaps the impediment most frequently quoted – and hardest to pin down - is the “political sensitivity” of space weapons.¹ This phrase is descriptive, in that it makes clear that the key political leadership, in both the Executive and Legislative Branches, has displayed a specific and detailed interest in this subject over the years, and, more importantly, has precisely steered the activities in this area. However, the term can also be misleading, if it creates an impression that this topic is somehow a partisan issue, or that the basis for senior leadership interest is rooted in the U.S. political system. Rather, like other topics of potentially great impact to the security of the nation, where almost polar-opposite approaches to a security concern have been proposed, the “political sensitivity” of space weapons is really an admixture of (primarily) philosophical and (secondarily) instrumental differences of opinion. That is, different sides in the debate either believe philosophically in completely different approaches to addressing the security concern (e.g., U.S. security is better served with or without an anti-ballistic missile defense system), or the two sides believe strongly about the different ways to implement a specific approach (e.g., for missile defense, whether space-based or ground-based weapons should do the job). Because these two issues – the basic philosophy and

the specific implementation – form the core of the “political sensitivity” issue, and recognizing that using the term “political sensitivity” may itself be unhelpful, this paper will instead refer to this area as the “policy impediment” to weaponization of space. This term should prove less confusing than the “political sensitivity” term, while being no less accurate, since the senior Executive and Legislative Branch leadership determines the national security policy after resolution of the “political sensitivities” on this issue. The other impediments to further space weaponization, in comparison to this policy issue, are relatively straightforward and do not need special explanatory remarks.

Examining all the impediments to space weapons, then, shows that they fall into five categories: policy, strategy, legal, organizational, and feasibility. A complicating factor for these impediments is that they not only can apply differently to specific weapons, but also to different stages of a weapon’s lifetime (i.e., to the research, design, fabrication, test, deployment, or employment phase). The analysis of impediments starts with a general discussion of each one, then moves on to apply the impediments to the appropriate sections of the Space Weaponization Taxonomy. The aggregated collection of impediments in the final section of this chapter shows the totality of items constraining further space weaponization progress.

Overview of Impediments

Each of the five impediments to further weaponizaion has unique aspects. Policy impediments are traceable to both philosophical and instrumental issues. Strategy impediments involve both doctrine and concept of operation issues. Legal impediments have both domestic law and international agreement aspects. Organizational impediments are related to the organizations that define requirements and accomplish

development for space weapons. And feasibility impediments exist because of technical and cost challenges for space weapons. The order in which these impediments are addressed is prioritized. Policy is most important because it determines what the country wants to do at the most general level. Strategy is next most important because it determines specifically how space weapons would be used to accomplish national objectives. Legal impediments then apply, limiting the acceptable space weapon options. Organization is next because it primarily determines the efficiency of pursuing a space weapon that is driven by the policy/strategy/legal framework. Finally, feasibility is certainly an important impediment, but is, after all, the challenge that every DOD development program is structured to overcome. These five impediment areas are discussed in detail below, then applied to specific elements of the Weaponization Taxonomy in the next section.

Policy Impediments

Policy impediments to further development of space weapons arise from two broad areas of concern: philosophical issues and instrumental issues. Philosophical issues revolve around the fundamental question of **whether** space weapons should be used for national security purposes. Instrumental issues revolve around the question of **how** space weapons should be used for national security purposes (given a decision to use space weapons for national security in the first place). The original policy impediments to space weapon development came from Pres. Eisenhower, who determined space could best be used in the monumental struggle against communism if it was free of weapons. Having decided not to use space weapons for national security, Pres. Eisenhower then directed how it would be used: to gather intelligence data on the denied territory of the

Soviet Union; to improve the capabilities of U.S. military forces; and to serve as a demonstration of U.S. scientific and technical prowess versus the Soviet Union to the rest of the world. This decision was not universally supported in Congress or DOD, but it nevertheless became the U.S. policy.² As this policy developed, Pres. Eisenhower directed military space activities to keep a low profile; space weapons programs were allowed only low-level research activity, given the perceived threat from the Soviet satellites, the state-of-the-art of space technology, and the desire not to stimulate Soviet space weapons that could attack U.S. satellites.³ This “no space weapons” policy was modified somewhat by Pres. Kennedy, who allowed (low profile) U.S. space weapon development activities commensurate with the increasing Soviet threat, which eventually produced the operational anti-satellite system the Air Force fielded on Johnston Island.⁴ Nevertheless, the U.S. basically followed a policy focused on the “peaceful use” of outer space, and became party to international treaties and other agreements which adhered to this principal. Therefore, the course set by Presidents Eisenhower and Kennedy continued in effect until Pres. Reagan took a decidedly more aggressive stand.⁵

With the advent of Pres. Reagan’s Strategic Defense Initiative (SDI) program, the U.S. aggressively pursued space weapons for defense of the homeland against ballistic missile attack. Anti-satellite weapons also were advocated, leading to the successful test of the air-launched Miniature Homing Vehicle (MHV) against a satellite in 1985 (this program had begun under Pres. Carter partly as a result of Soviet refusal to negotiate ASAT arms control). This period – the first Reagan term – also produced a Soviet initiative to ban space weapons.⁶ The U.S. did not support this initiative, and the U.S. continued major development efforts in both the SDI and ASAT programs.⁷ Later in the

1980's, under Pres. Bush, the U.S. moderated its space weapon efforts. Missile defense was taken off the fast-track for deployment, but ASAT was still "to develop and deploy a comprehensive capability with programs as required and with initial operations capability at the earliest possible date."⁸

In the 1990's, under Pres. Clinton, both the missile defense and ASAT efforts continued to receive advocacy within the National Space Policy, though practical support (i.e., funding levels) for these efforts were lower than previously. In fact, Congress advocated more aggressive missile defense and ASAT programs than did the administration, reflected by both Congressional funding plus-ups and Congressional report language.

From the foregoing summary of U.S. policy on space weapons, it should be clear that both Democratic and Republican presidents have supported space weapons at various times. It is also clear that Congress has supported space weapons at various times, including recently. Certainly, some people have opposed space weapons; there have been various Congressional bans on U.S. ASAT tests, and amendments proposed to ban space weapons for all time. However, for most people the issue has not been whether space weapons should be used for national security (the philosophical question), but rather how they should be used (the instrumental question). This practical concern about the details of the use of space weapons to promote national security has led to some specific policy restrictions on the development, test, deployment, and employment of space weapons. These restrictions are addressed next.

The instrumental aspect of the policy impediment addresses what types of space weapons are acceptable and what types are not. National Space Policy, the President's

declaratory policy on space, establishes the guidelines which DOD, as an executive branch department, must follow. Other Presidential and lower level executive branch policy guidance comes from other documents, including the National Security Strategy. The legislative branch – Congress – also exerts its influence on space weapons policy. Congress provides its guidance in law, usually the Defense Authorization Act, as well as in various committee and conference reports; the strongest impact is felt when funding is added or denied for specific programs. Together, the executive and legislative branches create a policy framework within which space weapon efforts must live. This policy framework currently has several key features:

The intention to work cooperatively with other nations to promote “peaceful” use of space⁹

The position that it is a sovereign right to acquire data from space¹⁰

The position that space systems are “national property with the right of passage through and operations in space without interference”¹¹

The position that “Purposeful interference with space systems shall be viewed as an infringement of sovereign rights”¹²

The position that U.S. space capabilities will support “U.S. inherent right of self defense and our defense commitments to allies and friends”¹³

The position that U.S. space capabilities should be able to defend against enemy attacks¹⁴

The position that U.S. space capabilities will be able to counter hostile space systems and services¹⁵

The position that “Consistent with treaty obligations, the United States will develop, operate and maintain space control capabilities to ensure freedom of action in space and, if directed, deny such freedom of action to adversaries.”¹⁶

The position that the U.S. will develop anti-ballistic missile capabilities for theater defense, have a readiness program for national defense, and have a technology to provide future improvements to both¹⁷

The position that “The design and operation of space tests, experiments and systems, will minimize or reduce accumulation of space debris consistent with mission requirements and cost effectiveness.”¹⁸

The position that U.S. will consider arms control and related measures for space only “if they are equitable, effectively verifiable, and enhance the security of the United States and our Allies.”¹⁹

Congressional funding above the President’s Budget Request of three programs related to space weapons (Army’s Kinetic Energy ASAT program, Clementine II experiment, and the military space plane)²⁰

Presidential veto of the same three programs related to space weapons (Army's Kinetic Energy ASAT program, Clementine II experiment, and the military space plane)²¹

Presidential statement in letter to Sen. Tom Harkin saying "I do not believe any threat yet justifies the near-term deployment of an operational ASAT capability. That is why last month I vetoed a \$37.5M Congressional appropriation to flight test the Army's KE ASAT program."²²

This policy framework has several practical effects. First, it explicitly enables Control of Space and Worldwide Missile Defense efforts (though not to the same degree); Worldwide Precision Strike capabilities are not addressed, leaving them in policy limbo. Second, it establishes a bias against weapons that create debris (kinetic energy weapons/experiments such as the Army's KE ASAT and Clementine II). Third, it establishes a bias against weapons that will cause major disagreements with international partners. Fourth, it establishes a bias for weapons with the ability to protect areas rather than specific satellites (the need to protect U.S. as well as allies and friends – who may change with each situation!). Fifth, it establishes a bias against peacetime weapon testing against non-cooperative satellites (e.g., Information Warfare probes of non-cooperative satellites). Sixth, it establishes a bias for weapons that have multiple target capabilities (since the full range of satellites and services may have to be denied to an adversary). While bias in favor of a particular kind of weapon system is not really an impediment, it is still useful to acknowledge where these preferences lie, since they suggest the priorities for development of space weapons once other impediments are removed. In this vein, beyond the directly traceable preferences listed above, there are at least a couple of derivative preferences that further suggest priorities. One important derivative preference would be for weapons that have temporary/reversible effects, which would help make them more acceptable internationally and provide the U.S. more flexibility against third

party satellites being used by an adversary. Another would be for weapons that are highly selective or surgical (e.g., can deny specific services on a satellite), again making them more acceptable and flexible.

Now, applying the foregoing policy guidelines to the space weapon taxonomy yields the following conclusions (summarized in Table 10). First, by mission area: worldwide missile defense is restricted to the “front half” of development activities (research, development, and some testing); worldwide precision strike is (implicitly) restricted by lack of any policy guidance to lower-level research activities (this is a “soft” constraint). The worldwide missile defense restriction results because of the (Presidential) policy guidance to only have “a national missile defense deployment readiness program as a hedge” – due to the inherently global nature of space weapons, any system that would be an effective theater missile defense system would also have some national missile defense capability, which is restricted by policy. The worldwide precision strike “soft” restriction occurs because, in the austere budget environment that currently exists, no Service is likely to commit any significant resources to a potentially-controversial new weapon system that does not have at least some explicit backing from the Administration. Second, applying the policy guidelines to specific weapons: nuclear, kinetic energy, and information warfare weapons each are restricted in some way. Nuclear weapons, both space-based and ground-based, have issues with international opinion and protection of U.S./allied/friendly satellites. These issues would make any possible weapon/target location mix, even in the concept development sense, problematic, and would certainly restrict testing or deployment of nuclear weapons in space during peacetime as well as operations in wartime. Kinetic energy weapons attacking a target in space would be

restricted by the policy guidelines on debris and protection of U.S./allied/friendly satellites; this would effect peacetime testing and wartime operations. And information warfare weapons would be restricted by the policy guidelines on viewing satellites as sovereign territory and any interference with their operations as an infringement on those rights.²³ This is due to the importance of determining potential information warfare attack paths and likely resulting system effects prior to a wartime attack.

Table 10. Policy Impediments to Space Weapons

Weapon Location	Target Location	Weapon Type	Impediment	Comments
Satellite Protection				
Earth	Space	Nuclear	Policy	International opinion; protection
“	“	Kinetic	“	Debris; protection
“	“	RF		
“	“	HPM		
“	“	Laser		
“	“	IW	“	Satellite sovereignty (testing)
Space	Space	Nuclear	“	International opinion; protection
“	“	Kinetic	“	Debris; protection
“	“	RF		
“	“	HPM		
“	“	Laser		
“	“	PB		
“	“	IW	“	Satellite sovereignty (testing)
Space	Earth	Nuclear	“	International opinion
“	“	Kinetic		
“	“	RF		
“	“	HPM		
“	“	Laser		
“	“	IW		
Worldwide Missile Defense				
Earth	Space	Nuclear	Policy	International opinion; protection; no deployment
“	“	Kinetic	“	Debris; protection; no deployment
“	“	HPM	“	No deployment

Weapon Location	Target Location	Weapon Type	Impediment	Comments
Space	Space	Nuclear	“	International opinion; protection; no deployment
“	“	Kinetic	“	Debris; protection; no deployment
“	“	HPM	“	No deployment
“	“	PB	“	“ “
Space	Earth	Nuclear	“	International opinion; protection; no deployment
“	“	Kinetic	“	No deployment
“	“	HPM	“	“ “
“	“	Laser	“	“ “
Worldwide Precision Strikes				
Space	Earth	Nuclear	Policy	International opinion; protection; no policy
“	“	Kinetic	“	No policy
“	“	RF	“	“ “
“	“	HPM	“	“ “
“	“	Laser	“	“ “
“	“	IW	“	“ “

Strategy Impediments

The lack of a recognized, viable strategy for the use of space weapons severely impedes the development of said capabilities. A series of recent wargames involving space systems and weapons highlighted this problem. This strategy problem is further compounded by the lack of suitable space warfare doctrine and suitable concepts of operation (CONOPS) for space weapons. For this paper, space warfare doctrine refers to DOD’s belief in the best way to conduct warfare in space (without specific reference to a particular weapon system). And, complementing this, CONOPS are what DOD believes are the best ways to operate a particular weapon system to achieve some mission. Strategy, then, would be the plan to use resources at hand (according to doctrine and individual weapon system CONOPS) to achieve national objectives. While several authors have advocated doctrines applicable to the use of space weapons, there is still

very little officially endorsed doctrine in place.²⁴ Likewise, though there have been discussions of CONOPS for various space weapon concepts, none has been universally recognized on even an individual basis, no less in an integrated “system of systems” sense. All these shortfalls impede further progress on space weapons because they fail to provide a concrete vision of how space weapons would be used in threat situations of concern to the U.S. The three shortfalls – lack of strategy, supporting doctrine, and space weapon CONOPS - are most easily illustrated in terms of the lessons learned from several important wargames which included space warfare.

There have been a number of wargames involving space, including space combat, over the last several years. These games have been sponsored by the Army, Navy, Air Force, Office of the Secretary of Defense/Office of Net Assessment (OSD/NA), and the Ballistic Missile Defense Office (BMDO).²⁵ The wargames have revealed several problems in the areas of strategy, doctrine, and CONOPS. Chief among these has been the need to develop an appropriate space warfighting strategy for each scenario that addresses issues including: when space weapons would be used, against which types of targets, which actions indicate or are likely to produce escalation, how third party space systems will be dealt with, and how counterspace operations will integrate with information operations.²⁶ Several of the above issues also could be mitigated by the appropriate doctrine, along with additional issues arising from the complexity of the space warfare environment, the stressing command and control aspects of some space weapons, and the appropriate U.S. response to various adversary space warfare activity. Finally, CONOPS would help resolve issues on use of space-based lasers (SBLs), trans-

atmospheric vehicles (TAVs), and radio-frequency weapons, all of which are favorites of wargamers when they are available.²⁷

Because there has been no operational experience with space weapons, and only very little developmental test experience, formulation of doctrine has been difficult. A number of authors – Lupton, Petersen, and Mantz, to name only a few – have proposed doctrines or theories for use of space weapons that recognize the unique characteristics of space. These doctrines and theories primarily have dealt with space control and the missile defense aspect of force application, though recently attention has also been given to the precision strike part of force application. However, these doctrines and theories have yet to be integrated into officially-sanctioned documents which can steer DOD efforts to further progress on space weapons. Without real operational experience to draw on, prospective space doctrine developers must use models, simulations and wargames, as well as analogies to other types of operational systems, to formulate space weapon doctrine. Unfortunately, the models and simulations available to support recent wargaming efforts have proven less than optimum, with the Pentagon office responsible for summarizing recent space play in wargames concluding “in the future, however, robust modeling and simulation (M&S) tools must be developed to add fidelity to the analysis of space warfighting concepts.”²⁸ This leads to the wargames being less useful than they might otherwise be in helping to form space warfare doctrine. And, in addition, there is another penalty to pay for not having credible models and simulations. Without these tools, there are no quantitative ways to estimate the impact of space weapons on various conflict scenarios, and, consequently, no way to determine the value of space

weapons versus other ways that DOD resources could be invested (i.e., in more traditional ground, sea, or air weapon systems).

The lack of approved CONOPS for the various potential space weapons also impedes efforts to develop the kinds of capabilities that the wargames that have been held to date indicate leaders prefer. In their summary of lessons learned from the various space wargames, AF/XOCD notes that players representing the National Command Authorities want capabilities that are not escalatory, preferring weapons that are surgical in their attacks and/or reversible in their effects.²⁹ Certain capabilities, namely space-based lasers, trans-atmospheric vehicles (TAVs), and electronic jamming capabilities, were especially desirable.³⁰ But there are no officially recognized CONOPS for these capabilities, or any other space weapons, that would give wargame players confidence in how these capabilities could reasonably be expected to work. And without reasonable confidence in the operations of these systems, it is unlikely that major investments will be made to develop and field them.

The impact of the lack of doctrine and absence of approved CONOPS is uncertainty about how space warfare might be fought in general and how specific weapons would contribute specifically. This in turn causes space weapon advocates to extrapolate from other, known systems to a space context, a practice that can lead to incorrect conclusions. Space weapon systems that are individually comparable to existing earth-based system get compared to the analogous earth-based system, and employment is projected from this perspective. This can penalize space systems in two ways: for those systems with an apparent terrestrial counterpart, it could lock the space system into an employment mode that is too limiting for its actual capabilities; for space weapons with no obvious

terrestrial analog, there could be both unease about its potential utility on one hand and unbounded optimism about what the system could do on the other. Any of these outcomes – too constraining visions of employment, no vision of employment, or too optimistic a vision of employment – will impede further development of space weapons. Examples may best illustrate this reasoning. Radio-Frequency (RF) space weapons could be seen as analogous to terrestrial RF jammers, which have been employed against radars and other sensors for decades. However, attributing RF space weapons with similar abilities might underestimate the ways in which RF space weapons could attack a target (at the most sophisticated end of the spectrum, this merges with Information Warfare). Particle beam space weapons could suffer from a total lack of vision as to employment, since these weapons are not analogous to terrestrial weapons and have certain unique features that provide both limitations on and opportunities for effective employment against space targets. And lasers, whether fully space-based or as a combined ground-based laser/space mirror, could suffer from the too optimistic vision of employment, where virtually unlimited capabilities are subscribed to it. This could occur because lasers, as a class of systems, can provide an incredibly broad range of militarily useful capabilities; but as individual, specific weapon systems, lasers have much less ability to be all things to all users.

Taking the (admittedly qualitative) ramifications of the above into account, and applying it to the space weapon taxonomy, several points can be made. Nuclear weapons against targets in space (and probably most point targets on the ground) are likely to suffer from extrapolation of existing nuclear weapon employment plans and cause a misperception of utility. RF space weapons are likely to be unduly constricted by

analogy to terrestrial counterparts, while HPMs and lasers are likely to be envisioned as having capabilities that are too optimistic when applied to individual weapon designs. Particle beams are likely to be poorly understood at best, and Information Warfare may suffer both from lack of vision on employment on one hand and too optimistic a vision of employment on the other hand. In sum, except for kinetic energy weapons, which can be extrapolated from analogy with terrestrial systems fairly well, all the space weapons are likely to be misunderstood and incorrectly utilized (see Table 11 below). This situation will not inspire confidence in space weapon capabilities and will impede pursuit of space weapon development until such time as military leaders believe there is better understanding of how space weapons can be used to achieve national security tasks.

Table 11. Strategy Impediments to Space Weapons

Weapon Location	Target Location	Weapon Type	Impediment	Comments
Satellite Protection and Negation				
Earth	Space	Nuclear	Strategy	Vision too constrained
“	“	Kinetic		
“	“	RF	“	Vision too constrained
“	“	HPM	“	Vision too broad
“	“	Laser	“	Vision too broad
“	“	IW	“	Vision too broad or absent altogether
Space	Space	Nuclear	Strategy	Vision too constrained
“	“	Kinetic		
“	“	RF	“	Vision too constrained
“	“	HPM	“	Vision too broad
“	“	Laser	“	Vision too broad
“	“	PB	“	Vision absent
“	“	IW	“	Vision too broad or absent altogether
Space	Earth	Nuclear	“	Vision too constrained
“	“	Kinetic		
“	“	RF	“	Vision too constrained
“	“	HPM	“	Vision too broad
“	“	Laser	“	Vision too broad

Weapon Location	Target Location	Weapon Type	Impediment	Comments
“	“	IW	“	Vision too broad or absent altogether
Worldwide Missile Defense				
Earth	Space	Nuclear	Strategy	Vision too constrained
“	“	Kinetic		
“	“	HPM	“	Vision too broad
Space	Space	Nuclear	“	Vision too constrained
“	“	Kinetic		
“	“	HPM	“	Vision too broad
“	“	PB	“	Vision absent
Space	Earth	Nuclear	“	Vision too constrained
“	“	Kinetic		
“	“	HPM	“	Vision too broad
“	“	Laser	“	Vision too broad
Worldwide Precision Strikes				
Space	Earth	Nuclear	Strategy	Vision too constrained
“	“	Kinetic		
“	“	RF	“	Vision too constrained
“	“	HPM	“	Vision too broad
“	“	Laser	“	Vision too broad
“	“	IW	“	Vision too broad or absent altogether

Legal Impediments

The legal impediments to further development of space weapon capabilities can be divided into two classes: one class, international agreement/treaty impediments, derives from international agreements and treaties to which the U.S. is a party; and the other class, domestic law impediments, derives from Congressionally legislated domestic U.S. law (including any “extra” restrictions where the domestic law exceeds the performance required by international agreement/treaty). As with previously discussed impediments, both these classes of legal impediments can effect different aspects of the development and deployment cycles for space weapons and treat different types of space weapons in different ways (e.g., nuclear weapons versus conventional weapons).

International legal impediments to further weaponization of space derive both from several multi-lateral treaties to which the U.S. is a party as well as several bi-lateral U.S./U.S.S.R. arms control treaties. The multi-lateral treaties include the United Nations Charter, the Limited Test Ban Treaty, several Direct Communications Link Agreements (1963, 1971, 1984), the Outer Space Treaty, the Astronaut Rescue and Return Agreement, the International Telecommunications Convention, the Convention on Registration of Space Objects, and the Environmental Modification Convention.³¹ The bi-lateral U.S./U.S.S.R. treaties include the Anti-Ballistic Missile (ABM) Treaty, the Strategic Arms Limitation Talks (SALT) I and II, and the Agreement to Reduce the Risk of Nuclear War.³² However, the net effect of these treaties is actually very limited. The key restrictions on the U.S. are: (1) weapons of mass destruction (nuclear, chemical, biological) cannot be stationed in space; (2) nuclear weapons cannot be tested in space; (3) space-based anti-ballistic missile systems capable of intercepting strategic ballistic missiles cannot be developed, tested, or deployed; and (4) there can be no interference with the National Technical Means (NTM) of treaty verification of the U.S.S.R. Article IX of the Outer Space Treaty levies another pertinent requirement on its signatories:

If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment.³³

This effectively prohibits a test against a non-cooperative satellite, if such a test could cause harmful interference, since, presumably, the prerequisite international consultations would lead to either an agreement that the test was acceptable or cause the test to be called off.

A key consideration for these treaties, like much of international law in general, is that they are only required to remain in effect during peacetime; signatories have the option of continuing to comply with the agreements (or not) in times of war.³⁴ This means that the international agreements serve to regulate activities that occur during peacetime, such as weapon system research/development/test/deployment, but not the wartime employment of weapons. Consequently, the majority of international legal impediments to space weapons would not be likely to remain in force during wartime if the U.S. viewed them as detrimental to national security and suspended treaty compliance. The same is obviously true for any other signatories of these agreements, even if these signatories had been complying with the treaty provisions prior to the conflict. Therefore, the primary remaining international legal constraints on space weapons in times of conflict would be that body of international law known as the Law of Armed Conflict; virtually all of the currently conceived space weapons would be compatible with these laws, as are other U.S. weapons.³⁵ The one remaining issue to be resolved in this regard is how Information Warfare attacks might be conducted, both in a strategic attack sense against foreign national infrastructures (the proportionality issue) and in a deception sense against foreign warfighting units (the perfidy issue).

The domestic law impediments to space weapons are the least problematic that they have been in the last two decades. During the mid 1980's, Congressionally legislated restrictions on air-launched MHV ASAT testing were a major cause of the program being cancelled. During the early 1990's, Congressionally-legislated restrictions on Mid-Infrared Advanced Chemical Laser (MIRACL) ASAT testing prevented any satellite tests from being attempted. Likewise, during the 1980's, Congressional restrictions on the

Strategic Defense Initiative Program limited the aggressiveness of its development program. However, the situation is very different in the late 1990's. There are no restrictions on ASAT testing, and MIRACL recently completed a test against a satellite that gathered data useful to both satellite survivability and ASAT communities. And, with the change in dominant party, Congress has taken a different tact with ballistic missile defense, now pushing for more aggressive development of a National Missile Defense program. The only domestic law that impedes space weapon activities is 18 U.S.C. 1367, which restricts tampering with satellites. The law specifies criminal prosecution for "whoever, without the authority of the satellite operator, intentionally or maliciously interferes with the authorized operation of a communications or weather satellite or obstructs or hinders any satellite transmission...."³⁶ This law resulted from the infamous "Captain Midnight" hacking event into a satellite broadcasting for the Home Box Office (HBO) cable TV channel.³⁷ This law would be problematic for attempts to "Shape" the international environment or "Respond" to a crisis prior to the outbreak of conflict, particularly by Information Warfare operations, if they were conducted from U.S. territory.

Applying the foregoing international and domestic legal impediments to the space weapons taxonomy results in Table 12 below. The table shows that space-based nuclear weapons and ABM-capable space weapons cannot be tested or deployed in space, but conventional space weapons for other missions are generally unrestricted. The one constraint on conventional space weapons is that they cannot do probing of non-cooperative satellites during peacetime for the purposes of determining satellite vulnerabilities *if that probing causes interference with the satellite's functioning*. For the

weapons for which this is a practical possibility – radio-frequency (RF), laser, information warfare (IW), and possibly high power microwave (HPM) weapons – only the IW weapons are likely to find this a significant restriction. This is due to the very system-specific nature of IW attacks and the need to thoroughly understand how the target system’s software (versus hardware) will react to an attack before estimating the potential results of an IW attack.

Table 12. Legal Impediments to Space Weapons

Weapon Location	Target Location	Weapon Type	Impediment	Comments
Satellite Protection and Negation				
Earth	Space	Nuclear	Legal	No tests in space
“	“	Kinetic		
“	“	RF	Legal	No peacetime probing of non-cooperative satellites
“	“	HPM	“	Same as earth-to-space RF
“	“	Laser	“	Same as earth-to-space RF
“	“	IW	“	Same as earth-to-space RF
Space	Space	Nuclear	Legal	No tests or deployment in space
“	“	Kinetic		
“	“	RF	Legal	No peacetime probing of non-cooperative satellites
“	“	HPM	“	Same as space-to-space RF
“	“	Laser	“	Same as space-to-space RF
“	“	PB		
“	“	IW	“	Same as space-to-space RF
Space	Earth	Nuclear	Legal	No above-ground tests; no deployment in space
“	“	Kinetic		
“	“	RF		
“	“	HPM		
“	“	Laser		
“	“	IW		
Worldwide Missile Defense				
Earth	Space	Nuclear	Legal	No tests in space; only one deployment site allowed
“	“	Kinetic	“	Only one deployment site allowed

Weapon Location	Target Location	Weapon Type	Impediment	Comments
“	“	HPM	“	Only one deployment site allowed
Space	Space	Nuclear	Legal	No tests in space; no ABM development, test, or deployment
“	“	Kinetic	“	No ABM development, test, or deployment
“	“	HPM	“	No ABM development, test, or deployment
“	“	PB	“	No ABM development, test, or deployment
Space	Earth	Nuclear	Legal	No above-ground tests; no ABM development, test, or deployment
“	“	Kinetic	“	No ABM development, test, or deployment
“	“	HPM	“	No ABM development, test, or deployment
“	“	Laser	“	No ABM development, test, or deployment
Worldwide Precision Strikes				
Space	Earth	Nuclear	Legal	No above-ground tests; no deployment in space
“	“	Kinetic		
“	“	RF		
“	“	HPM		
“	“	Laser		
“	“	IW		

Organizational Impediments

The rate of further progress in space weapon capabilities is effected by two closely-related organizational issues. The first issue is the inefficient nature of the current organizational structure responsible for doing the requirements determination/operations planning for space weapons. The second issue is the inefficient nature of the current organizational structure responsible for the development of space weapons. Both these issues impede progress on space weapons, though in hard to quantify ways.

USSPACECOM, with its Service component commands, has primary responsibility for determining the requirements and doing operations planning for Control of Space and Worldwide Missile Defense capabilities.³⁸ USSPACECOM is also seeking to gain responsibility to define the requirements and plan the operations for Worldwide Precision Strike capabilities, though this is likely to be challenged by other unified commands and/or Service commands (that are not components of USSPACECOM). In a sense, this is a question of whether space weapons will have an identity primarily as space weapons, or instead as weapons to do a certain mission (e.g., strategic attack). If the space weapon identity predominates, then USSPACECOM would almost certainly succeed in being designated the lead for requirements and operations planning for space weapon use. But, if the mission these weapons perform becomes the dominant identifier for the capabilities, then it is likely that, for instance, Air Combat Command (ACC) would contend that it should define the requirement for deep conventional strike capabilities within the AF instead of AFSPACECOM. Of course, this would lead to ACC also expecting the weapons to be assigned to ACC when they become operational, to conduct conventional deep strike operations just as a B-2 could do. In addition, regarding the potential use of specially-designed nuclear weapons for space control or force application purposes, it is unclear how DOD's requirements for capabilities get transmitted to the Department of Energy and its national laboratories, which are responsible for the U.S. nuclear inventory. This makes any prospective nuclear space weapon efforts even more problematic than they otherwise would be due to policy and legal issues.

The development cycle issue basically involves the lack of efficiency of the current organizational arrangement, which has three Services doing different space weapon

efforts. The organization decision effects the degree of emphasis that space weapons will enjoy, and thereby the resources which are devoted to this undertaking. The current approach, with the Army, Navy, and Air Force all pursuing different systems, is not working optimally. Both the Army and the Air Force are developing space weapons to do the space control and missile defense missions (with the Ballistic Missile Defense Office also involved with some of the missile defense systems), while the Navy also is doing missile defense work. The Army, responsible for both the kinetic energy ASAT program and the MIRACL laser testing, has only devoted minor Army resources to these efforts.³⁹ Since space control is not a core Army competency, this is not too surprising. The Army has invested considerably more effort into its ballistic missile defense programs, one of which, Theater High-Altitude Area Defense (THAAD), qualifies as a space weapon because of its reach.⁴⁰ The Air Force has devoted significant Service resources to the Airborne Laser (ABL) theater ballistic missile defense program, which the SECDEF has identified as an emerging capability to also help perform the space control mission.⁴¹ And the Air Force has recently embraced the Space-Based Laser (SBL) program for ballistic missile defense, which also has a collateral capability to do part of the space control mission; however, the AF is still struggling to allocate sufficient resources to make the program viable. Further, with the Air Force's declared intention to evolve from an Air Force to an Air and Space Force on the way to a Space and Air Force, the commitment to develop the entire spectrum of military space capabilities seems to have been made. However, the budget pressures between the increasingly important space missions and the also increasingly important air missions will put the Air Force in a very difficult position over the next few years. Several observers, including some senior

AF generals, have expressed the hope that the AF can find a way to allocate sufficient resources to make the future vision a reality, but they also have expressed skepticism about how this can occur under likely funding constraints.⁴² And, even if the AF can find funds to make an increased investment in space, there will be inexorable pressure to invest in the force enhancement space capabilities that make existing AF (and Army, Navy, and Marine) weapons more effective, rather than in space weapon systems that might replace these legacy earth-based weapons. This situation has led to speculation that the nation needs an organization dedicated just to the purposes of developing space systems. This new Service, a Space Force, could focus all DOD space efforts – and possibly intelligence efforts also – in an efficient and effective manner. From a space weapon perspective, the virtue, then, of this new Service would be that it would see space weapons as the most important thing it had to pursue, because space weapons would be the warfighting element of the new Service – its *raison d'être*. This new Service approach would virtually guarantee that a larger amount of funding would be allocated to space weapon development than under either the current multi-Service approach or a single existing Service approach to developing space weapons. The problem created by the speculation about the need for a Space Force is that it has wasted considerable mental energy of those most knowledgeable about space, particularly within the Air Force, and has therefore detracted from the pursuit of the transition from an air force to an eventual space and air force. And, finally, because of its Navy Theater Wide ballistic missile defense program, the Navy will also become a player in the space weapon business and have to be integrated into whatever efforts are pursued.⁴³

The net outcome of both the operational planning and developmental organization issues is that certain space weapon mission areas and system concepts have received less attention than they otherwise might have, and no comprehensive assessment of on-going efforts in the entire mission area/system mix has been done. This most hurts the Worldwide Precision Strike mission area and the kinetic energy and ground-based laser systems (because there is actually some effort on-going in these), though all areas and system concepts suffer under the current structure. And, more than any other space weapon phenomenology, Information Warfare suffers from a surplus of interested parties, all competing for a piece of the new Information Operations mission area (and the new funding which is expected to accompany it). Until IW matures, and decisions are made on who is in charge and what they are expected to accomplish, any IW space weapon concepts are likely to be handicapped at best, if not completely neutered. The organizational impediments to further progress in space weapons are shown in Table 13 below.

Table 13. Organizational Impediments to Space Weapons

Weapon Location	Target Location	Weapon Type	Impediment	Comments
Satellite Protection and Negation				
Earth	Space	Nuclear		DOD/DOE interaction
“	“	Kinetic	Organizational	Not Army priority/yet to find sufficient resources
“	“	RF		
“	“	HPM		
“	“	Laser	“	MIRACL not Army priority; competing Service organizations
“	“	IW	“	Surplus of players/no lead
Space	Space	Nuclear		DOD/DOE interaction
“	“	Kinetic		
“	“	RF		

Weapon Location	Target Location	Weapon Type	Impediment	Comments
“	“	HPM		
“	“	Laser	Organizational	AF yet to find sufficient resources
“	“	PB		
“	“	IW	“	Surplus of players/no lead
Space	Earth	Nuclear		DOD/DOE interaction
“	“	Kinetic		
“	“	RF		
“	“	HPM		
“	“	Laser	Organizational	AF yet to find sufficient resources
“	“	IW	“	Surplus of players/no lead
Worldwide Missile Defense				
Earth	Space	Nuclear		DOD/DOE interaction
“	“	Kinetic		
“	“	HPM		
Space	Space	Nuclear		DOD/DOE interaction
“	“	Kinetic		
“	“	HPM		
“	“	PB		
Space	Earth	Nuclear		DOD/DOE interaction
“	“	Kinetic		
“	“	HPM		
“	“	Laser	Organizational	AF yet to find sufficient resources
Worldwide Precision Strikes				
Space	Earth	Nuclear	Organizational	No clear ops/rqmts lead; DOD/DOE interaction
“	“	Kinetic	“	No clear ops/rqmts lead
“	“	RF	“	No clear ops/rqmts lead
“	“	HPM	“	No clear ops/rqmts lead
“	“	Laser	“	No clear ops/rqmts lead [
“	“	IW	“	Surplus of players/no lead

Feasibility Impediments

The last category of impediments to further progress on space weapons is the “feasibility” area. Here, feasibility refers to the ability of the U.S. to actually achieve the capabilities desired once all other impediments have been removed. In other words, once the U.S. has embraced a policy that calls for space weapons and created strategies for

their use that are compatible with international agreements and domestic law, then organized appropriately to plan and develop the desired weapons, what remains that would prevent the U.S. from actually getting the capabilities it seeks? The two prime impediments at this point would be the (prospective) non-availability of the necessary technology to build the space weapons, and the (potentially) prohibitive costs of developing the technology, integrating it into a workable system, testing it, deploying it, and maintaining it at a state of readiness until needed. It would be possible to subsume one of these impediments (technology) into the other one (cost) if one believes that enough money can overcome any technical problem (given time). This paper does not subscribe to this assumption, especially when the time to achieve the desired capability is considered an important factor in its own right; the paper therefore treats technology availability and cost as separate impediments. However, the paper only deals with these two impediments in the most summary fashion, because meaningful determinations of technology availability and cost are largely determined by the specific space weapon system designs, which is beyond the scope of this paper. Therefore, this paper only makes qualitative assessments of both these impediments: the in-depth assessments would be part of the work done if this paper succeeds in helping channel more effort into space weapons. If this occurs, then enough work would be done in the area to make fair comparisons with other, more traditional methods of accomplishing the missions which space weapons could also perform.

With the foregoing in mind, then, the technology and cost impediments are driven by a few key factors. For technology, the factors are when the technology will be available and where it is based. Specifically, if the technology exists now (e.g., nuclear warheads),

then the technical risk (impediment) is low (some risk exists to integrate the technology into a working system); if the technology is “near-term” (available in the next 5-10 years), then the technical risk is moderate; if the technology is “far-term” (greater than 10 years away), then the technical is high. Basing any technology in space increases the technical risk one level, i.e., a technology with low risk for a ground-based weapon system rises to moderate risk for a space-based system. The cost impediment is driven by three factors: basing mode for the weapon system, mission to be performed, and maturity of the primary weapon technology. These three broad factors encompass derivative factors such as number of systems needed, maximum supportable engagement rate, reliability of the system, and weight in orbit (for space-based systems). As an example, a space weapon with mature technology, ground-basing, and the least challenging mission would have the lowest cost risk; conversely, a space weapon with immature technology, space-basing, and the most challenging mission would have the highest cost risk. The rationale for the cost “bias” against space systems is that it is notoriously expensive to put objects in orbit, and, once there, very difficult to perform maintenance on them. This drives the cost of space-based systems to be higher in general than ground-based systems, which do not have to optimize their use of weight or have the high reliability of space systems. Of course, some missions can only be performed efficiently from space - that’s why global missile launch warning and wide-area communications have been the province of space systems for several decades. Nevertheless, there could be a high price to pay for gaining the global effectiveness of space-based system and this must be acknowledged.

Taking the technical and cost impediment guidelines stated above and applying them to the space weapon taxonomy leads to the following conclusions. First, technology: nuclear, kinetic energy, and Radio Frequency (RF) technology is basically mature and has low technical risk. Nuclear weapons have existed for decades, been demonstrated in space, and have armed operational ASAT systems.⁴⁴ Kinetic energy weapons have similarly existed for decades and been demonstrated in space against satellite targets.⁴⁵ And RF technology has been around even longer, pre-dating the space age in its military uses; it has also been identified as a potential Soviet ASAT capability.⁴⁶ High power microwave (HPM) and laser technology is near-term and has moderate technical risk; particle beam (PB) technology is least mature and has high technical risk. HPM technology has been explored for decades; the Soviets were credited with doing HPM work for ballistic missile defense and ASAT purposes in the 1980s.⁴⁷ Lasers are being weaponized in both the Airborne Laser (ABL) and Space-based Laser (SBL) programs. ABL has just awarded a six and a half year contract to complete program definition and risk-reduction, while SBL has awarded several concept study contracts intended to define the path to an operational demonstration between 2005 and 2008.⁴⁸ There are currently no space-based neutral particle beam efforts known to the author, so it is highly unlikely the technology for a weapon system could be available any sooner than 10+ years. Offensive Information Warfare (IW) is not currently seen as requiring new technology; however, since offensive IW requires access to targets and an understanding of the operating systems of the targets, it is possible that new technology might be useful. Nevertheless, existing technology should support (perhaps a better word is allow) IW attacks. Regarding ground- vs space-basing, any of the technologies can be based in

either location, except for the particle beam weapon; as stated above, technical risk will increase one level when any of the technologies is based in space.

Turning to the second impediment, cost, the guidelines place earth-to-space weapons in the lower cost range, while space-to-space and space-to-earth weapons are in higher ranges. More challenging missions, like worldwide missile defense (adversary picks attack time, many targets may be launched at once, price of any missed targets is high), have higher cost risk than less challenging missions, like satellite negation (U.S. picks attack time, multiple methods/systems can contribute to negation, targets can be prioritized). Worldwide Precision Strike is closer to the more challenging end of the spectrum - many likely targets, potentially located anywhere on globe, probably with time-critical suspense. Satellite protection is closer to the less challenging end - passive techniques can help lessen threat impact, fewer targets for U.S. weapons to attack, position of U.S. satellites and (likely) threats will be known; adding allied/friendly satellites to this does make it much more challenging, but this quickly leads to the conclusion that space weapons will play only a limited role in protecting everyone else's satellite capabilities. Finally, regarding technology, the mature technologies (nuclear, kinetic energy, RF, IW) will have lower cost, while near-term technologies (HPM and laser) will have higher cost; far-term technology (particle beam) will have the highest cost. It is worthwhile to note that a factor not dealt with here, but which will be important in detailed costing exercises, is the question of weapons that are multi-shot, or reusable. These reusable weapons would have lower aggregate costs than expendable systems, such as nuclear or kinetic energy weapons (this would also apply to HPM weapons if explosively-driven and, to a lesser degree, space-based lasers if not

refuelable). A final point to keep in mind is that the cost of any of the space weapons is not the determining factor by itself - it must be compared to the cost (and effectiveness) of the alternative terrestrial weapon systems that could also perform the missions, given that the missions are essential to U.S. national security to begin with. Unfortunately, this cannot be done until the impediments to further space weapon development are removed and additional work is done on these concepts.

Aggregating both the technical and cost impediments to space weapons yields the results shown in Table 14 below. Note that the cost risk varies across six categories: low, low/medium, medium, medium/high, high/very high, and very high. This seemingly fine gradation of admittedly qualitative factors is necessary to gain the proper insight into the cost impediment because of the variety of potential permutations of the three factors. The ranges of the factors are: weapon basing (lower risk for earth and higher for space); mission (lower for satellite negation and protection, higher for missile defense and precision strike); and technology maturity (low for available now, medium for near-term, and high for far-term). Taken in the preceding order (basing/mission/technology), the combinations can be: lower/lower/low = low cost risk; higher/lower/low = medium; lower/higher/low = medium; lower/lower/medium = low/medium; higher/lower/medium = medium/high; lower/higher/medium = medium/high; higher/higher/medium = high/very high; higher/higher/low = high; higher/lower/high = high; higher/higher/high = very high. Note that, though there are 12 potential combinations (2x2x3), two of the combinations are not allowed since particle beams cannot be earth based (i.e., cannot have lower/lower/high or lower/higher/high combinations). In Table 15 below, all the scores are shown, but only those with a score of medium or higher are identified (by **bold**

letters) as having a feasibility impediment (this is a fairly conservative approach – the cutoff could just as easily be made for scores of “high” and above).

Table 14. Feasibility Impediments to Space Weapons

Weapon Location	Target Location	Weapon Type	Impediment	Comments
Satellite Protection and Negation				
Earth	Space	Nuclear		Technology risk (impediment) is low; cost risk (impediment) is low
“	“	Kinetic		Tech – low; cost - low
“	“	RF		Tech – low; cost - low
“	“	HPM	Feasibility	Tech - medium ; cost – low/medium
“	“	Laser	“	Tech - medium ; cost – low/medium
“	“	IW		Tech – low; cost - low
Space	Space	Nuclear	Feasibility	Tech – medium; cost - medium
“	“	Kinetic	“	Tech – medium; cost - medium
“	“	RF	“	Tech – medium; cost - medium
“	“	HPM	“	Tech - high; cost – medium/high
“	“	Laser	“	Tech - high; cost - medium/high
“	“	PB	“	Tech – very high; cost – high
“	“	IW	“	Tech – medium; cost – medium
Space	Earth	Nuclear	Feasibility	Tech – medium; cost - medium
“	“	Kinetic	“	Tech – medium; cost - medium
“	“	RF	“	Tech – medium; cost - medium
“	“	HPM	“	Tech - high; cost – medium/high
“	“	Laser	“	Tech - high; cost – medium/high
“	“	IW	“	Tech – medium; cost - medium
Worldwide Missile Defense				

Weapon Location	Target Location	Weapon Type	Impediment	Comments
Earth	Space	Nuclear	Feasibility	Tech – low; cost - medium
“	“	Kinetic	“	Tech – low; cost - medium
“	“	HPM	“	Tech – medium; cost – medium/high
Space	Space	Nuclear	Feasibility	Tech – medium; cost - high
“	“	Kinetic	“	Tech – medium; cost - high
“	“	HPM	“	Tech – high; cost – high/very high
“	“	PB	“	Tech – very high; cost – very high
Space	Earth	Nuclear	Feasibility	Tech – medium; cost - high
“	“	Kinetic	“	Tech – medium; cost - high
“	“	HPM	“	Tech – high; cost – high/very high
“	“	Laser	“	Tech – high; cost – very high
Worldwide Precision Strikes				
Space	Earth	Nuclear	Feasibility	Tech – medium; cost - high
“	“	Kinetic	“	Tech – medium; cost - high
“	“	RF	“	Tech – medium; cost - high
“	“	HPM	“	Tech – high; cost – high/very high
“	“	Laser	“	Tech – high; cost – high/very high
“	“	IW	“	Tech – medium; cost - high

Combined Impediment Evaluation

Combining the five impediment categories into one table shows the entire range of challenges that must be overcome by any given space weapon mission area or specific weapon phenomenology. There are several pertinent observations that can be made from this compilation. First, there are no mission areas without impediments. Each of the four missions (satellite protection, satellite negation, worldwide missile defense, and worldwide precision strike) has some type of impediment that applies to any of the weapon phenomenologies that it could develop. Further, there are impediments that apply to whole mission areas (worldwide missile defense and worldwide precision

strike), regardless of the phenomenology for the space weapon. Second, there are a few mission/phenomenology combinations which have no policy/legal constraints (viewed as more critical or “hard” impediments), while several others are only partially restricted by these type of constraints, in a way that would still allow meaningful progress to be made (e.g., restrictions on RF, laser, and HPM testing against non-cooperative satellite targets is not likely to be a significant problem). Third, two of the constraints (Strategy and Organization) are largely within the control of DOD, and a third (Feasibility), can be significantly influenced by DOD efforts. This means that, once Policy and Legal impediments are resolved/mitigated, DOD will essentially be in control of the progress of space weapon development.

Table 15. Combined Impediments to Space Weapons

Weapon Location	Target Location	Weapon Type	Impediments				
			Policy	Strategy	Legal	Org.	Feasibility
Satellite Protection & Satellite Negation							
Earth	Space	Nuclear	Yes	Yes	Yes	Yes	
“	“	Kinetic			Yes	Yes	
“	“	RF		Yes	Yes		
“	“	HPM		Yes	Yes		Yes
“	“	Laser		Yes	Yes	Yes	Yes
“	“	IW	Yes	Yes	Yes	Yes	
Space	Space	Nuclear	Yes	Yes	Yes	Yes	Yes
“	“	Kinetic	Yes				Yes
“	“	RF		Yes	Yes		Yes
“	“	HPM		Yes	Yes		Yes
“	“	Laser		Yes	Yes	Yes	Yes
“	“	PB		Yes			Yes
“	“	IW	Yes	Yes	Yes	Yes	Yes
Space	Earth	Nuclear	Yes	Yes	Yes	Yes	Yes
“	“	Kinetic					Yes
“	“	RF		Yes			Yes
“	“	HPM		Yes			Yes
“	“	Laser		Yes		Yes	Yes

Weapon Location	Target Location	Weapon Type	Impediments				
			Policy	Strategy	Legal	Org.	Feasibility
“	“	IW		Yes		Yes	Yes
Worldwide Missile Defense							
Earth	Space	Nuclear	Yes	Yes	Yes	Yes	Yes
“	“	Kinetic	Yes		Yes		Yes
“	“	HPM	Yes	Yes	Yes		Yes
Space	Space	Nuclear	Yes	Yes	Yes	Yes	Yes
“	“	Kinetic	Yes		Yes		Yes
“	“	HPM	Yes	Yes	Yes		Yes
“	“	PB	Yes	Yes	Yes		Yes
Space	Earth	Nuclear	Yes	Yes	Yes	Yes	Yes
“	“	Kinetic	Yes		Yes		Yes
“	“	HPM	Yes	Yes	Yes		Yes
“	“	Laser	Yes	Yes	Yes	Yes	Yes
Worldwide Precision Strikes							
Space	Earth	Nuclear	Yes	Yes	Yes	Yes	Yes
“	“	Kinetic	Yes			Yes	Yes
“	“	RF	Yes	Yes		Yes	Yes
“	“	HPM	Yes	Yes		Yes	Yes
“	“	Laser	Yes	Yes		Yes	Yes
“	“	IW	Yes	Yes		Yes	Yes

Notes

¹ AF/XOCD, *Space Doctrine and Strategy Issues: Integrated Wargaming Lessons* (Washington, DC: Air Force, 1997), 1. See also Gen. Howell M. Estes III, *Speech for the Air Force Association International Air Power Symposium* (Colorado Springs: USSPACECOM, 1997), 6; and Lt. Col. Michael R. Mantz, *The New Sword: A Theory of Space Combat Power* (Maxwell AFB, AL: Air University Press, 1995), 11-12.

² Major Roger C. Hunter, *A US ASAT Policy for a Multipolar World* (Maxwell AFB, AL: Air University Press, 1992), 16-17.

³ Ibid., 18-21.

⁴ Ibid., 25-26.

⁵ Ibid., 36-37.

⁶ Ibid., 35.

⁷ Ibid., 36-37.

⁸ President George Bush, *National Space Policy Directives and Executive Charter: NSPD-1*, 1, available on-line, Internet, 2 February 1998, at <http://www.hq.nasa.gov/office/codez/nspdl.html>.

⁹ National Science and Technology Council, *Fact Sheet: National Space Policy* (Washington, D.C.: National Science and Technology Council, 1996), 2, available on-line, Internet, 2 February 1998, at <http://www.hq.nasa.gov/office/oss/spacepol.htm>.

¹⁰ Ibid.

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¹¹ Ibid.

¹² Ibid.

¹³ Ibid., 5.

¹⁴ Ibid.

¹⁵ Ibid.

¹⁶ Ibid., 6.

¹⁷ Ibid., 7.

¹⁸ Ibid., 15.

¹⁹ Ibid., 14.

²⁰ AFSPC Legislative Liaison, *Legislative Update*, 6 February 1998, 1, 7, and 13.

²¹ Ibid.

²² AFSPC Legislative Liaison, *Legislative Update*, 12 December 1997, 2.

²³ National Science and Technology Council, *Fact Sheet*, 2.

²⁴ AF/XOCD, *Space Doctrine and Strategy Issues: Integrated Wargaming Lessons* (Washington, DC: Air Force, 1997), 3. See also Lt. Col. Michael R. Mantz, *The New Sword: A Theory of Space Combat Power* (Maxwell AFB, AL: Air University Press, 1995), 8-10.

²⁵ AF/XOCD, *Space Doctrine*, 2. See also HQ SWC/AE, "Space Issues/Lessons Learned...Army After Next, Navy Global and Global Engagement '97," 08/07/97 briefing, 3.

²⁶ AF/XOCD, *Space Doctrine*, 2-13. See also HQ SWC/AE, "Space Issues/Lessons Learned," 7 and 10.

²⁷ AF/XOCD, *Space Doctrine*, 8 and 10.

²⁸ Ibid., 3.

²⁹ Ibid., 5.

³⁰ Ibid., 5, 8, and 10.

³¹ Major Steven R. Petersen, *Space Control and the Role of Antisatellite Weapons* (Montgomery, AL: Air University Press, 1991), 89. See also Office of Technology Assessment, *Anti-Satellite Weapons, Countermeasures, and Arms Control* (Washington, DC: U.S. Government Printing Office, September 1985), 91-94.

³² Petersen, *Space Control*, 89. See also Office of Technology Assessment, *Anti-Satellite Weapons*, 91-94.

³³ Institute for Professional Development, "Treaty on Principles Governing Space Activities," *Selected Readings on Space* (Maxwell AFB, AL: Air University, January 1970), 309.

³⁴ Petersen, *Space Control*, 89-91. See also Office of Technology Assessment, *Anti-Satellite Weapons*, 91-94.

³⁵ This is an aggressive statement, but the author believes it is indeed true. Lt Col Walter Sharp, Sr., formerly the Deputy Legal Counsel to the CJCS, during a 21 October 1997 presentation on Information Warfare, summarized the essential test of the Laws of Armed Conflict with an acronym: MUP. This stands for Military Necessity, Unnecessary Suffering, and Proportionality. Any proposed attack, and the weapon that carries it out, must balance these three concepts in a defensible way. The space weapons that the author has seen discussed, and that this paper contemplates, have great precision

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and selectivity, and should therefore be as capable as other advanced U.S. weapons of meeting the MUP test successfully.

³⁶ Colonel Phillip A. Johnson, *Opening Shots: Information Warfare and the Law* (Washington, D.C.: SAF/GC, 1997), B-2.

³⁷ Author's notes from Colonel Phillip A. Johnson's presentation to the "Legal Aspects of Information Operations Symposium" at the Judge Advocate General School on Maxwell AFB, AL, on 20 October 1997.

³⁸ ???????, Office of the Chairman, Joint Chiefs of Staff, Memorandum, To: Chief of Staff Army et al, Subject: Implementation of the Unified Command Plan, 9 February 1998, 13, (Secret), information extracted is unclassified.

³⁹ In FY95, FY96, and FY97, Congress added money for MIRACL and KE ASAT efforts to keep them alive, since they were not funded by the Army. Pres. Clinton line-item vetoed the FY98 Congressional funding for the KE ASAT program, helping to trigger charges that he was not properly fulfilling the national policy to be able to exert control of space if necessary.

⁴⁰ "THAAD TMD," *FAS Space Policy Project Special Weapons Monitor*, 28 December 1997, 1-2, On-line, Internet, 31 March 1998, available from <http://www.fas.org/spp/starwars/program/thaad.htm>.

⁴¹ AFSPC Legislative Liaison, *Legislative Update*, 6 February 1998, 7.

⁴² Several general officers, both guest speakers at Air War College and visitors to Air University, have noted this concern during the last several months. There seems to be a real "wait & see" attitude about whether the Air Force will be able to clearly enunciate its strategy for transitioning from an air force to an air and space force, then a space and air force, and then match resources to this strategy. They have all noted the significant budget pressures on the Air Force, and the major challenge posed by the need to locate funding to make the transition a reality. Several of these generals have speculated that a failure on the Air Force's part to do this would cause a severe problem, one answer to which could be creation of a new Service that focuses on space.

⁴³ "Navy Theater Wide [LEAP]," *FAS Space Policy Project Special Weapons Monitor*, 28 December 1997, 1-3, On-line, Internet, 31 March 1998, available from <http://www.fas.org/spp/starwars/program/leap.htm>.

⁴⁴ Jack Raymond, "Theory Disputed: Tests Appear to Bar 'Umbrella' to Halt Enemy Missiles," *New York Times*, 20 Mar 1959, 1. See also Franklin A. Long, Donald Hafner, and Jeffrey Boutwell, editors, *Weapons in Space* (New York: W. W. Norton & Company, 1986), 22-23.

⁴⁵ "Year of Decision for ASAT Program," *Science* Vol. 236 (19 June 1987): 1512-1513. See also Nicholas L. Johnson, *Soviet Space Programs 1980-1985* (San Diego, CA: 1987), 137-142.

⁴⁶ *Soviet Military Power* (Washington, DC: U.S. Government Printing Office, 1986), 46. See also Johnson, *Soviet Space Programs*, 137-142.

⁴⁷ *Soviet Military Power* (Washington, DC: U.S. Government Printing Office, 1985, 1986, 1987, and 1988), 45, 47, 51, and 146, respectively, for each publication year listed.

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⁴⁸ “Dynamite with a Laser Beam,” *Aviation Week & Space Technology* Vol 148, No. 7 (16 February 1998): 13. And private communication between author and Col. Douglas Loverro, Space-Based Laser program director, on 23 March 1998.

Chapter 6

Actions to Mitigate Impediments

This chapter discusses how to alleviate the five categories of impediments that constrain space weapon developments. The summary table at the end of the preceding chapter shows how each mission area, weapon/target location category, and weapon phenomenology is effected by impediments. One or more DOD actions are proposed to mitigate or eliminate each constraint, along with a subjective assessment of how easy or difficult the action would be for DOD to accomplish. There is also a brief comment on the advancement of space weaponization that would result for each action accomplished.

Policy Impediments

The root of the policy impediment to further progress in space weapons is the lack of domestic consensus that this is the right course for the U.S. to pursue. Other factors, such as international opinion, can be overcome/mitigated with a focused diplomatic effort once a consensus for U.S. action is reached. Since policy is largely created at the highest levels of government, above DOD, the only real action available to DOD is advocacy to senior policy makers. The purpose of this advocacy would be to shape the impending national debate on space weapons in a way that most advantageously promotes DOD's position. And, from DOD's perspective, the most effective mechanism with which they can shape the debate is technically and historically accurate information on space

weapons. Properly presented, such information could be crucial in carrying the space weapon debate, leading to domestic consensus on the further weaponization of space. The crucial information would cover activities in the past, the present, and the future. Information about the past will show how the military has used space from the very beginning of the space age, and how space weapons have been part-and-parcel of this use, albeit in a low-profile way. It will also show how efforts to ban space weapons have had very limited success, and make clear why this will continue to be true in the future. Information about the present will show the extent of U.S. dependence on space, in both a national economic as well as a purely military sense. And information about the future will show how the national dependence on space is going to grow, and how this will make defense of space assets of even greater importance. But, also in the future, opportunities to use space to project national power will blossom as technology matures and innovative ways to employ that technology create more effective means to accomplish the nation's objectives. Once fully mindful of these facts, the nation will be able to reach consensus on the right course of action and pursue the further weaponization of space with the appropriate vigor and priority.

Information on the Past

The first element of critical information that DOD must provide to senior U.S. executive and legislative decision-makers – and their supporting staffs – is on the history of space, including the weapons that have been developed and tested. This is especially important because of the generally low-level of publicity given military space, and especially space weapon, programs versus civil/commercial space programs, as discussed at the end of Chapter 2. Since senior decision-makers are wary of the challenges of doing

precedent-setting tasks, an awareness of the actual history of space weapons will give them the right context to help formulate effective explanations of new U.S. initiatives. Understanding the reasons for President Eisenhower's original creation of the "space sanctuary" school of thought, and why later Administrations – and Congresses – perpetuated this approach, is useful background. And understanding why President Reagan concluded the time was right to abandon the "space sanctuary" doctrine in the 1980's is also important. Likewise, knowing that both the U.S. and U.S.S.R. have separately determined that comprehensive anti-satellite weapon bans could not be adequately verified helps address the inevitable question on the potential role of arms control and suggests the less-than-optimistic prospects for future applications.¹

Information on the Present

The second major element of information that DOD must provide is on the current U.S. and international use of space. The extensive use of space by the U.S. for all manner of national activities – civil, commercial, military, and intelligence – has greatly enhanced the effectiveness of U.S. efforts. However, this use of space has created a new vital interest for the U.S., and presented a huge challenge to the military to protect key elements of the national infrastructure that are no longer within the physical borders of U.S. territory. At the same time, increasing use of space by other nations has also enhanced their effectiveness, while creating some new vulnerabilities for them, also. With the increasing number of countries with access to space – not to mention other technologies that allow power to be projected into space – the likelihood of earth-bound conflicts spreading to space is growing rapidly. However, given the present situation and the current growth trends, the U.S. will be the country that gains the most from space and

thereby also has the most vulnerability to loss of space capabilities. This fact, more than any other, will be the compelling force that drives potential U.S. adversaries into developing capabilities to combat America's asymmetric space advantage. The prospect of these potential adversaries – Iraq, Iran, Libya, etc – agreeing to arms control agreements, no less actually complying with them, is not encouraging. This reality must be acknowledged, and the appropriate conclusions drawn about the current U.S. situation. Once this is done, senior U.S. decision-makers will be more inclined to pursue countervailing capabilities both to defend U.S. space assets as well as to project power against the space – and terrestrial – assets of potential adversaries.

Information on the Future

The third major element of information DOD must provide would cover the likely future situations that the U.S. will encounter in the 21st Century. The numerous forward-looking studies on this – the QDR report, the NDP report, 2025, *New World Vistas* – all envision futures where the U.S. will need the capability to exert force, hopefully in a coalition structure, but unilaterally if necessary. All of these studies also call for the capability to defend U.S. space assets, which the studies envision coming under hostile attack. These studies effectively dismiss the near-term applicability of projections by optimistic futurists like Francis Fukuyama, believing instead that the first 30 years of the next millenium will be more like the chaotic end of this century than a peaceful world of liberal democracies. And there are certainly a host of other authors that predict all manner of potential sources of conflict, from competitions for things – water, food, oil, land – to disagreements over things – religion, ethnic composition, pace of reform, etc. In this future world of continuing conflict, the major forward-looking studies see the need

for the U.S. to be able to use its technological prowess to effectively conduct national security efforts; space weapons certainly hold the promise to do this consistent with the kinds of capabilities all the studies seek. And, at least in the AF-directed studies that looked at the specific mission of the Service, space weapons were explicitly identified as being high-leverage, asymmetric capabilities that the U.S. could employ to effectively carry out national defense tasks. When this future-oriented information is integrated with the past and present space history information in the two sections above, it will make a compelling rationale for modification of existing U.S. policy to enable further progress on space weapon development.

Mechanisms for Education Process

The mechanisms that DOD can use to conduct its advocacy campaign to shape the space weapon debate include, first, internal communications within the Administration, then, second, external communications with Congress and other influential decision-makers and key advisors. DOD would likely play a supporting role in any communications with the American public or international organizations/agencies/players on this topic. Internal communications must be concluded first to gain Administration approval and endorsement for external advocacy. These communications should occur at multiple levels, from staff interactions between DOD and the National Security Council all the way to senior DOD interactions at the President/Vice President Level. Succinct summary briefings and point papers are the most viable methods, though longer background briefings and white papers will need to be exchanged between staffs.

Once internal approval and advocacy has been gained, at least for taking the pulse of Congress and discovering the most sensitive areas of concern, then interactions outside of

the Executive Branch can begin. These interactions will likely take the form of Congressional testimony and reports to Congress, with the appropriate number of in-depth Congressional staff prep briefings and written responses to questions.

Though the process is likely to take several years to fully play itself out – and will in fact never get out of the stage where various instrumental approaches to developing space weapon capabilities are debated – major activity could begin as early as the spring of 1998. This activity is prompted by the considerable interest displayed by certain Congressional members (Sen. Lott, Sen. Inhofe, Sen. Smith, and Rep. Rohrabacher, to name a few) in various space weapon-related topics, such as National Missile Defense and space control.² And, adding an immediate impetus, is the recent letter to President Clinton from a large group of senior defense experts urging him to “heed the recommendations of the National Defense Panel with respect to assuring an American capability to “deny our enemies the use of space.” Your leadership will be essential in assuring the means necessary to provide space dominance and in rejecting budgetary and arms control arrangements that would jeopardize that required capability.”³

Outcome from Education Process

How will DOD know when sufficient education has taken place? Well, the ultimate confirmation will occur several years down the line, when space weapons have been developed, tested, fielded, and, eventually, employed successfully. In the near-term, the measure will be when the majority of key decision-makers reach consensus that something more must be done, and resources are allocated to pursue a selected course of action. The first stage of this course of action will be completion of sufficient research – largely unfettered by policy constraints - to allow fair trade-offs between space weapons

and other, more traditional methods of accomplishing the specific missions. Additional progress beyond this stage will depend on how technology matures, both for space weapons and other, competing weapon concepts, as well as how the perceived threat situation that these weapons must address also evolves. To sustain the momentum of the selected course of action, education must be a continuing process, acquainting each new Administration and Congress with the rationale for why space weapons are important and effective tools within the U.S.' overall national defense structure.

Policy Recommendations

DOD should take these specific actions to mitigate/eliminate the policy impediments to space weapon development:

1. Separate space control, ballistic missile defense (worldwide missile defense), and worldwide precision strike into three distinct areas of discussion
2. Assign lead responsibility for developing the appropriate advocacy/debate shaping information for each of the three distinct areas; this should include any recommended changes in National Space Policy wording
3. Coordinate information on the three distinct areas to ensure they are mutually supporting, but not mutually dependent
4. Engage NSC staff on the topic, seeking support for later presentations to Pres./Vice Pres.
5. Investigate Congressional environment through personal contacts
6. Identify and support an early initiative to deploy an operational space control space weapon; the candidate must be strong enough to succeed, thereby establishing an important precedent in the present international environment
7. Identify and support an early initiative to deploy a weapon in space; the candidate must be very strong to establish this important precedent

Strategy Impediments

Since strategy impediments are largely within the control of DOD, more direct action can be taken to address them. DOD can develop strategy/doctrine/CONOPS necessary to enable effective use of space weapons to achieve U.S. national objectives. Of course,

space weapons will be only one part of the capabilities that the U.S. brings to bear to achieve these objectives, but, depending on the scenario, space weapons could be a major contributor to success.

Several on-going activities provide a running start to resolving the strategy impediment. The increasingly sophisticated space activity in all the Services' Title X wargames forces game players to think more seriously about space weapons and their possible uses. The ad hoc strategies developed for each of these wargames still suffer from not having a doctrinal base to work from, or specific weapon concepts of operation to plan on, but the exercise of developing the strategies is nevertheless useful. And the doctrine and CONOPS situation is improving. Both the Army and Air Force have efforts underway to develop doctrine for space weapons. The Army work is being done by the new Force Development and Integration Center of the U.S. Army Space and Missile Defense Command; previous work by the Army's Training and Doctrine Command (TRADOC) provides a base on which the new center can build.⁴ The Air Force's work is being done at its new doctrine center on Maxwell AFB. The Force Development and Integration Center, with its Concepts and Doctrine Division, develops doctrine for space and missile defense systems.⁵ TRADOC has produced a draft *Army Space Reference Text*, which includes a chapter on the Army's concept of space as well as an annex with the Army's space policy. This document, along with FM 100-18 Space Support to Army Operations, will help educate Army personnel on what they can expect from space systems and what the Army believes to be the best way to use those space systems.⁶ And on the second front, USSPACECOM is actively developing the CONOPS for the Space-Based Laser, which will include performing both ballistic missile defense and space

control missions, and may also include worldwide precision strike.⁷ While Air Combat Command is developing a CONOPS for the Airborne Laser, the recent SECDEF decision to use the ABL's capability to contribute to the space control mission has not yet been factored into the CONOPS. Though these doctrine and CONOPS efforts will all help, additional steps must be taken to relieve the strategy impediment.

Strategy Recommendations

DOD should take these specific actions to mitigate/eliminate the strategy impediments to space weapon development:

1. Develop a reference set of space capabilities, including weapons, to be used in all the Service future wargames and studies/simulations (this set would include a rudimentary CONOPS for each system); coordinate with each Service to ensure this reference set is understood and used
2. Develop models which integrate space systems, including weapons, into terrestrial combat scenarios; these models must show the impacts of the space systems on the outcomes of the scenarios in ways consistent with the impacts of terrestrial systems
3. Complete development of joint and Service space doctrine directives/manuals (which include some discussion of space conflict and weapons) and disseminate broadly; incorporate into formal education programs for all military personnel
4. Develop detailed CONOPS for selected space weapon systems, either to prepare for potential near-term use or to develop understanding of potential benefits to better advocate the development of the desired capability

Legal Impediments

Similar to the policy impediment, legal impediments are determined by agencies outside DOD's control; DOD's role in addressing these impediments is basically as an information supplier. DOD supplies information necessary to determine whether a proposed effort would violate a legal constraint; this information could also include explanations of additional U.S. actions that would be possible if the laws or agreements were modified. DOD also supplies information that is helpful in determining whether

prospective new laws or international agreements would restrict activities that are crucial to the defense of the U.S., potentially making these new laws/agreements not in the best interests of the U.S.

The legal impediments to space weapons primarily derive from international agreements, which the U.S. government could choose to cease complying with once appropriate notification had been given. If the U.S. were to seek modification of the ABM Treaty, or decide to abrogate the treaty entirely, then the U.S. would be free to pursue worldwide missile defense with a variety of space weapon systems, not just one based on the earth at a single site. Likewise, if the U.S. were to opt out of the treaties constraining nuclear weapons testing and/or basing in space, then additional options for space weapons would appear for all missions. However, the likelihood of a change to the ABM Treaty seems much greater than the likelihood of the U.S. not complying with the constraints on Weapons of Mass Destruction (WMD).

Regarding the ABM Treaty, Sen. Helms has recently made it clear that the Congress wants to review the Clinton Administration's plan to recognize Russia, Ukraine, Kazakhstan, and Belarus as the successors to the Soviet Union with respect to treaty compliance.⁸ If the Congress does not concur with this change in responsible parties, the treaty would effectively cease to exist. Without an ABM Treaty, the U.S. would be free to more aggressively pursue an effective National Missile Defense System using a variety of weapons, including space weapons. In this debate, DOD would provide any information requested by the Executive or Legislative Branches, through approved channels, to help clarify what actions the U.S. can take under existing treaty, as well as

additional actions that would be possible if the treaty were modified or ceased to exist entirely.

In addition to providing information on the impact of existing treaties, DOD also can provide valuable information on the effects of any new agreements or laws that might be proposed on space weapon activities. Such information would be an important component in the U.S. response to any new space weapon arms control initiatives, such as those proposed by President Yeltsin in his letter to President Clinton late in 1997.⁹ Since the current legal impediments to space weapons are relatively few, and the permitted activities reasonably broad, the most important role DOD might well play regarding this area is to help preserve the existing benign legal environment. Under the current situation, where the U.S. is not pursuing an aggressive space weapon development program, this task seems relatively easy. However, if the U.S. does gear up a program with the prospects of producing an effective space weapon in the foreseeable future, then activities in the recently quiescent Conference on Disarmament in Geneva may also resume.¹⁰ There may also be domestic U.S. activity seeking to limit space weapon activities, as happened with the air-launched Miniature Homing Vehicle ASAT in the 1980's and the MIRACL system in the early 1990's.

Legal Recommendations

DOD should take these specific actions to mitigate/eliminate the legal impediments to space weapon development:

1. Develop a white paper/briefing summarizing the existing legal constraints on space weapons (particularly IW weapons), the possible additional flexibility gained if these constraints were modified/removed, and the net effect on U.S. security of any changes to international legal restrictions
2. Develop a white paper/briefing summarizing historic failed arms control initiatives regarding space weapons, documenting why these initiatives failed and noting

whether conditions have changed in any way that would significantly effect the desirability of these initiatives from the U.S. perspective

3. Maintain proactive liaison with National Security Council staff to enable early participation in any discussions on new arms control agreements that might effect space weapons.
4. Maintain proactive legislative liaison activity to gain/maintain Congressional support for any space weapon activities pursued

Organizational Impediments

Like the Strategy Impediment, the Organizational Impediment is largely within the control of DOD. With the exception of the interaction with DOE on nuclear weapons and the Information Warfare (IW) issue, all the other organizational relationships/issues are contained within DOD. The resource limitation issue, experienced by both the Army and AF, could be resolved by each Service internally (though certainly at some impact to other efforts), or by OSD in its controlling role for the overall DOD budget. The priorities given various space weapon efforts within the Army are primarily within the control of the Army hierarchy, and could easily be balanced better between space control and ballistic missile defense missions if that was the decision. The sometimes unhealthy level of competition between the Army and AF directed energy efforts could be moderated, taking as an example the cooperative efforts that have gone on in the past between Army efforts at the High Energy Laser System Test Facility (HELSTF) at White Sands, NM, and the AF efforts at the former Phillips Laboratory at Kirtland AFB, NM. The recently discussed possibility of a Tri-Service Directed Energy Office at Kirtland AFB, representing the equities of the Army, Navy, and AF, could make a major improvement in cooperation and eliminate any unnecessary duplication of effort. Regarding the IW area, DOD must await the outcome of the on-going discussions about national responsibilities for this new area. However, DOD does not have to wait

passively, but could actively participate in – and even shape the outcome of - the responsibility discussions so that potential defense applications are enhanced. Interactions with DOE on nuclear weapons, while potentially challenging because of the general climate regarding nuclear weapons and the interest of the national labs in diversifying so that they are not left without anything to do, could still be productive and might produce innovative capabilities that are unachievable by any other approach.

Organizational Recommendations

DOD should take these specific actions to mitigate/eliminate the organizational impediments to space weapon development:

1. Establish a space weapon liaison with the DOE to determine the potential of advanced nuclear weapons to perform any of the space control or force application missions.
2. Actively engage in discussion on national allocation of IW responsibilities; ensure that the potential role of IW in space control and force application is appreciated and protected.
3. Jointly review the Service space weapon programs and determine if there are any overlaps or areas of potential synergy; share information and facilities where practicable.
4. Determine whether the KE ASAT program and MIRACL testing merits Army resource support given their potential to meet USSPACECOM requirements; Army fund accordingly or request OSD re-assign programs
5. Create a Tri-Service Directed Energy Weapon (DE) office at Kirtland AFB to consolidate DOD DE programs.

Feasibility Impediments

Feasibility impediments apply in some degree to any space-based space weapon, but in particular to the more advanced technology systems (HPM, laser, PB). The more challenging mission areas (worldwide missile defense, worldwide precision strike) also have more difficult feasibility issues. However, these feasibility impediments are by no means insurmountable, and, in fact, would be the focus of any space weapon

development programs that were initiated as a result of this paper successfully arguing for more progress.

Technical Feasibility

Taking the technical feasibility impediment first, DOD should continue several on-going initiatives to focus military research work to those unique requirements of DOD, while heavily relying on the growing commercial space effort to make progress in other areas. The Air Force Research Lab (AFRL) has embraced this strategy for space vehicle technology, and has done work to identify those technical areas in which DOD must fund work; other areas should be sufficiently funded by commercial sources.¹¹ Leveraging the investments made by the increasingly large commercial space effort, DOD will be able to most effectively use its limited space research and development funding to drive down risk in key areas. Weapon technologies, especially the higher leverage ones like high energy lasers, are likely to require significant DOD investment due to the lack of commercial applications. Because of expected funding limits, once specific weapon concepts have been selected for more in-dept study and preliminary development work, DOD will need to focus both space and weapon technology efforts even more narrowly on these concepts. The starting point of the technology, and the resources that DOD expects to have available, will indicate the schedule on which a particular space weapon concept could be fielded; this fact will of course help determine which space weapon concepts get pursued, based on national assessments of when the capability would be needed.

Cost Feasibility

Regarding the cost impediment, two trends will prove helpful in reducing costs of space weapons, at least the space-based ones. The commercial space business, like DOD, is acutely interested in driving down the costs of satellite launch. Consequently, various efforts are underway to drive launch costs lower and lower. Also, recent breakthroughs in micro-machines and nano-technology promise to make certain subsystems, especially sensors, much smaller and lighter, an important factor in saving launch costs.

Feasibility Recommendations

DOD should take these specific actions to mitigate/eliminate the technical and cost impediments to space weapon development:

1. Identify weapon concepts of interest, then identify the key technologies for those concepts, the state of the art of those technologies, and the improvements needed in the state of the art to make the weapon concepts effective
2. Convene all DOD and other governmental laboratories with pertinent technology capability/experience and determine how they can contribute to the development effort
3. Ensure all space and weapon technology R&D efforts are evaluated for applicability to selected concepts, and those with applicability receive higher utility grades and funding support
4. Continue efforts to reduce launch costs, with attention to medium to heavy payloads for space-based weapons
5. Pursue nano-technology vigorously, including appropriate design and testing for space environments

Categorization of Impediments

Based on the detailed review earlier, three categories of actions suggest themselves, falling under the somewhat subjective titles of “easy to do,” “moderately hard to do,” and “difficult to do.” Each of these categories is explained below, along with the actions that fall within them. Taking any of these actions will allow DoD to make some progress on

the further weaponization of space; taking all the actions would completely open space to all potentially interesting space weaponization activities.

Easy to Change Impediments

These changes require a minimum of effort by DOD. They require minimum resources (dollars/people) or minor organizational changes and can be accomplished within a short time period from decision to proceed (days to weeks). They are usually within DOD's authority to approve. An example is the first policy recommendation, which separates space control, ballistic missile defense, and worldwide precision strike into distinct mission areas: this action requires minimal resources, minimal organizational impact, can be accomplished quickly, and is within DOD control.

Moderately Hard to Change Impediments

These changes require a more substantial effort by DOD. They require a moderately large amount of resources or significant organizational changes, and may take months or longer to accomplish. They often are within DOD's authority to approve, but not in every case. An example is the second strategy recommendation, which develops models to integrate space system activity into terrestrial combat scenarios: this action requires moderate resources (to get useful models that really can integrate), requires moderate personnel commitment, takes a moderate time to accomplish, and is within DOD's control.

Difficult to Change Impediments

These changes require a major, concerted effort by DOD. They require substantial resources or major organizational changes and may take years to accomplish. They are

usually not within DOD’s authority to approve. An example is the seventh policy recommendation, which seeks to create a program to demonstrate a space-based weapon: this action requires significant resources, will take a long time, and is not entirely within DOD’s control because the Administration and Congress must approve the decision and use of significant funds for the program.

Summary Assessment of Impediment Difficulty

Taking the recommendations listed in each impediment section earlier in this chapter and evaluating them in terms of the items within the three categories above produces Table 16 below. The first evaluation category, resources, is graded on whether a small (S), moderate (M), or large (L) amount of dollar and/or personnel resources is needed to accomplish the action. The second evaluation category, organization, is graded on whether a small (S), moderate (M), or large (L) organizational change is needed to accomplish the action. The third evaluation category, time, is graded on whether a small (S), moderate (M), or large (L) amount of time is needed to accomplish the action; notionally, “S” equates to weeks, “M” to months, and “L” to years. The fourth evaluation category, DOD control, is graded on whether the action is within DOD’s authority to approve (Y) or outside of DOD’s authority to approve (N). Finally, the last evaluation column shows the (subjective) overall assessment of whether an action is “Easy” (E), “Moderately Difficult” (M), or “Difficult” (D).

Table 16. Assessment of Recommendations

#	Short Description	Resource	Org.	Time	DOD Control	Assess ment
Policy Recommendations						
P1	Separate into 3 areas	S	S	S	Y	E
P2	Assign lead for 3 areas	S	S	S	Y	E

#	Short Description	Resource	Org.	Time	DOD Control	Assessment
P3	Coordinate 3 areas	S	S	M	Y	E
P4	Engage NSC staff	S	S	M	N	M
P5	Investigate Congressional state	S	S	M	N	M
P6	Support Space Control demo	M	S	M	Y	M
P7	Support weapon in space demo	L	S	L	Y	D
Strategy Recommendations						
S1	Develop ref. set of space wpns	M	S	M	Y	E
S2	Develop space wpn models	M	S	M	Y	M
S3	Complete doctrine	S	S	M	Y	M
S4	Develop CONOPS	M	S	M	Y	M
Legal Recommendations						
L1	Summarize constraints	S	S	S	Y	E
L2	Summarize failed initiatives	S	S	S	Y	M
L3	Liaison w/NCS staff	S	S	M	N	M
L4	Liaison w/Congress	S	S	M	N	M
Organizational Recommendations						
O1	Liaison w/DOE	S	S	M	N	M
O2	Engage in national IW debate	M	M	M	N	D
O3	Joint review of sp wpn pgms	S	S	M	Y	E
O4	Eval KE ASAT & MIRACL	M	S	M	Y	M
O5	Create Tri-Service DE office	S	M	M	Y	M
Feasibility Recommendations						
F1	Eval wpn concepts & tech	S	S	M	Y	E
F2	Convene DOD/gov't labs	S	S	S	Y	E
F3	Eval R&D vs selected concepts	M	S	M	Y	M
F4	Reduce launch costs	M	S	L	N	D
F5	Pursue nano-tech	M	S	L	Y	M
F6	Pursue remote refuel/repair	M	S	L	Y	D

Using the (admittedly subjective) evaluation process described earlier, the table shows there are 10 “Easy” actions, 12 “Moderately Difficult” actions, and 4 “Difficult” actions. Accomplishing the “Easy” actions enables DOD to more effectively: coordinate activities, wargame potential effects of space weapons, and advocate lessening of legal constraints. Accomplishing the “Moderately Difficult” actions enables DOD to gain and maintain Administration and Congressional support for changes in policy and law, develop an initial space weapon capability and appropriate models, reorganize and

revitalize existing space weapon efforts, and pursue new technology. Accomplishing the “Hard” actions enables DOD to: field a space-based weapon, protect the DOD options for IW, reduce launch costs, and accomplish remotely controlled satellite refueling and repair.

Notes

¹ Major Roger C. Hunter, *A US ASAT Policy for a Multipolar World* (Maxwell, AL: Air University Press, May 1992) 33 and 37. See also Nicholas L. Johnson, *Soviet Space Programs 1980-1985* (San Diego, CA: American Astronautical Society, 1987) 147.

² AFSPC Legislative Liaison, *Legislative Update*, 30 January 1998, 2. Also AFSPC Legislative Liaison, *Legislative Update*, 6 February 1998, 7.

³ AFSPC Legislative Liaison, *Legislative Update*, 16 January 1998, 5-6.

⁴ United States Army Public Affairs, “U.S. Army has a new Major Command,” *ARMY LINK News*, 1997, 1; on-line, Internet, 28 October 1997, available from <http://www.dtic.mil/armylink/news/Oct1997/a19971014smdc.html>.

⁵ Force Development Integration Center, “Force Development Integration,” 1997, 1; on-line, Internet, 22 Feb 1998, available from <http://www.smdc.army.mil/SMDCPresent.html>.

⁶ HQ TRADOC, *Army Space Reference Text*, 1997, n.p.; on-line, Internet, 2 February 1998, available from <http://www-tradoc.army.mil/index> all/usr1/web.docs/dcsd/spaceweb/internet2.htm.

⁷ SAF/AQ and AF/XOF, *Staff Activity Information for the Commander*, 17-30 January 1998, 1.

⁸ AFSPC Legislative Liaison, *Legislative Update*, 30 January 1998, 11. And also The Center for Security Policy, “Unhappy Birthday: Twenty-Five Years of the A.B.M. Treaty is Enough; Sen. Kyl Points Way to Begin Defending America,” 23 May 1997, 3; on-line, Internet, 11 February 1998, available from <http://www.security-policy.org/papers/1997/97-D72.html>.

⁹ B.Yeltsin, President of Russia, To Willam J. Clinton, President of U.S., letter, unofficial translation, n.d. See also AFSPC Legislative Liaison, *Legislative Update*, 1 December 1997, 2. And Bill Gertz, “Yeltsin letter reveals anti-satellite weapons,” *The Washington Post*, 7 November 1997, 1-3, On-line, Internet, 31 March 1998, available from http://www.fas.org/spp/military/program/asat/wt971107_asat.htm.

¹⁰ *The Report of the Conference on Disarmament to the General Assembly of the United Nations* for 1997 explains that there was no activity on the issue of “Prevention of an Arms Race in Outer Space” during that year’s session.

¹¹ This approach was briefed to the group of AWC students and faculty visiting the AFRL location at Kirtland AFB on 23 September 1997.

Chapter 7

Conclusion

There are important reasons that the U.S. should continue to weaponize space. Every major study that has looked at future defense needs has noted that space-based assets will play an increasingly greater role in an effective U.S. defense, and will consequently become the object of enemy countermeasures. In the same vein, though to a lesser degree, enemy use of space will be a threat to U.S. forces. In both cases, the U.S. will need capabilities that space weapons could provide effectively; in some situations, space weapons might provide the only viable means to accomplish U.S. objectives. And beyond these traditional space control activities, many future-oriented military studies also see roles for space weapons in ballistic missile defense and force application against terrestrial targets. The promise of more timely and precise weapon effects makes space weapons highly attractive in an age more and more concerned with “come as you are” conflicts and absolute minimum casualties and collateral damage. Some people might even say that there is a moral imperative to pursue weapons that offer protection against attacks on the U.S. homeland on one hand and provide methods to precisely attack selected targets in an enemy’s homeland on the other.

Unfortunately, the current environment for space weapons contains several impediments that inhibit the most efficient pursuit of these new capabilities. Various

policy, strategy, legal, organizational, and feasibility constraints interfere with actions that DOD could take to further the weaponization of space that was begun at the dawn of the space age. Honest differences of opinion about the best way to use space for the nation's benefit, coupled with misunderstandings about the real history of space weapons, team to create policy constraints on DOD. With a strong effort, DOD can help shape the debate on the efficacy of space weapons, relieving these constraints and opening the way for more aggressive space weapon assessment and development efforts. DOD can also take internal actions to address the strategy constraints that create confusion about the value of space weapons and detract from advocacy arguments. Regarding legal impediments, DOD can certainly pursue a number of space weapon concepts within the existing legal framework, though further clarification in some areas would be helpful; DOD's most important task may be in working to prevent the legal environment from becoming more restrictive than it currently is. Organizational constraints impede efficient on-going efforts and make new efforts less likely to succeed: as a minimum, better coordination of efforts is essential; some consolidation of activities seems advisable. Finally, feasibility issues must be addressed if the most promising space weapon concepts are ever to come to fruition.

With the appropriate action, DOD can advance the cause of space weapons to the nation's overall benefit. Without action, the U.S. will be left without capabilities that might save countless lives and treasure, and leave the nation's objectives unmet in an increasingly complex and competitive world. To paraphrase General Estes' opening epigraph in the first chapter, actions taken now set the course for the next 25 years, determining the situation that our children and grandchildren will inherit. Hopefully, the

legacy that DOD provides will be one that protects the greatest number of lives by using the most effective means possible to perform the national defense mission. This paper envisions that space weapons will be an integral part of that legacy and endeavors to aid their development in some small way. Time will tell if it succeeds.

Appendix A

Definition of Space Weapon

Background

The United Nations has had a long – and still continuing - interest in promoting the peaceful uses of outer space. There are two groups which promote this interest: the United Nations' own Committee on the Peaceful Uses of Outer Space (COPUOS) and the U.N.-affiliated Conference on Disarmament (CD). The COPUOS is chartered to address and promote all the potential peaceful uses of space; the U.S. is insistent that this charter does not include military uses of space.¹ Military and arms control-related issues for space are the responsibility of the CD in Geneva. The CD was “established in 1979 as the single multilateral disarmament negotiating forum of the international community.”² The CD, at the U.N. General Assembly's request, created an Ad Hoc Committee to address the issue of an Arms Race in Outer Space. Though active for many years, the CD did not re-establish the Ad Hoc Committee in 1995, 1996, or 1997 due to the lack of a pressing need.³ However, during the Ad Hoc Committee's earlier active period, it compiled a number of definitions for space weapons, which were reported in a 21 July 1986 document, quoted here to provide useful context for the space weapon definition proposed by this paper:

Compilation of definitions of space weapons

The present compilation contains definitions of space weapons as proposed by delegations. It was prepared by the Secretariat pursuant to the decision of the Ad Hoc Committee at its 6th meeting on 4 July 1986.

Bulgaria and Hungary

Space strike weapon is:

- (a) any weapon system based entirely or partially in space, which is specifically designed and intended to destroy, damage or interfere with the normal functioning of, objects in space or on Earth, including its atmosphere, or
- (b) any weapon system, whether land-based, sea-based, or air-borne, which is specifically designed and intended to destroy, damage or interfere with the normal functioning of, space objects.

China

A space weapon means any device or installation either space-, land-, sea-, or atmosphere-based, which is designed for attacking or damaging spacecraft in outer space, or disrupting their normal functioning, or changing their orbits, and any device or installation based in space (including those based on the moon and other celestial bodies) which is designed for attacking or damaging objects in the atmosphere, or on land, or at sea, or disrupting their normal operation.

Sri Lanka

Any weapon or a component of a weapon or a device, whether ground-based or space-based, in Earth orbit or in any trajectory beyond Earth orbit, designed physically to damage or interfere with or attack a space object, or to attack ground or air-borne targets from space is a space weapon.

Union of Soviet Socialist Republics

In the view of the Soviet delegation, this concept includes, firstly, all space-based weapons intended for action against objects in space or on the Earth, including the Earth's atmosphere. Secondly, it includes weapons, wherever based, intended for action against space objects.

What specific types of weapon fall within this definition? Firstly, anti-satellite weapons, wherever based (in space, in the air, at sea, on land or mobile) and whatever their principle of operation. Secondly, space-

based anti-missile weapons, again whatever their principle of operation. Thirdly, space-based “space-to-Earth” weapons intended to attack objects on the Earth and in the Earth’s atmosphere.

Venezuela

“Space strike weapons” means any offensive or defensive device, including its operational components, whatever the scientific principle on which its functioning is based:

- (a) capable of destroying or damaging from its place of deployment in outer space an object situated in outer space, in the air, in water or on land.
- (b) Capable of destroying or damaging from its place of deployment in the air, in water or on land an object situated in outer space.

The following are also space strike weapons: any offensive or defensive device including its operational components and any system of such devices, whatever the scientific principle on which its functioning is based, that is capable of intercepting, from outer space or from land, water or the atmosphere, ballistic projectiles during their flight.

German Democratic Republic

The following definitions are proposed:

ASAT System

- Any device or installation based entirely or partially on land, sea, in the air and/or in outer space which is specifically designed and intended to destroy, damage or interfere with the normal functioning of space objects.

Space Object

- Any object put in outer space that circles the Earth at least once in an unpowered flight or stays in outer space at least for the minimum period of such revolution.

Outer Space

- Space around the Earth above an altitude of 100-110 km. Any height between these borders may be chosen by the appropriate body. Document A/AC. 105/C. 2/L. 139 of the Committee on

the Peaceful Uses of Outer Space could serve as a basis for that decision.⁴

Discussion

From the above definitions, several common points emerge: space weapons can either be located in space or attack objects in space; space weapons are specifically designed to perform their weapon function; and space weapons can destroy, damage, or just interfere with the normal operations of its target. With little modification, these points have been incorporated into the definition of space weapons stated by this paper in Chapter 2. The definition in Chapter 2 does clarify an issue not specifically stated in (most of) the above international definitions: namely, what constitutes a space object (regardless of whether this object is the weapon or the target). This paper subjectively identifies a location above 90 km, either for objects in orbit or on a ballistic path, as defining a space object. Both these altitude and ballistic path definition decisions are conservative. The 90 km altitude is conservative (though consistent with the 50 mile altitude for the U.S. astronaut rating) since this is a very low altitude, well below any orbital satellite path; this altitude may be revised upward when on-going COPUOS discussions on the limits of space reach their conclusion.⁵ Inclusion of objects on a ballistic path is also conservative; this was done partly as a concession to the Soviet (Russian) position and partly a conservative approach to avoid criticism about dodging the hard issue of ballistic missile defense. As stated earlier in Chapter 2, these definition decisions may certainly be criticized, but the arguments that result will undoubtedly be healthy for the subject area and are therefore welcomed.

Related Comment on Terminology

A final note before leaving the discussion of the space weapon definition. Over the years, there has developed a direct association between the term anti-satellite (ASAT) and the “destroy” form of negation. Consequently, the term ASAT has polarized the debate on the space control negation function. This apparently has occurred, at least in part, because there are several pieces of baggage that come along with the typical vision that detractors of ASATs seem to have, namely, a vision of a kinetic energy missile impacting a satellite and creating a huge cloud of debris in space. This is, of course, the most extreme form of negation, and actually the most extreme form of destruction (satellites can be destroyed by other methods that do not cause debris). This unfortunate association between the term ASAT and the kinetic energy destroy form of negation does no flow from the term itself, since an anti-satellite could refer to any weapon that performs a negation mission against a satellite. Nevertheless, this association seems to be widespread, and anyone planning to do work in the space weapon area should be aware of this relationship.

Notes

¹ “Recommendations and Decisions,” *Report of the Committee on the Peaceful Uses of Outer Space: General Assembly Official Records Forty-Ninth Session*, United Nations Office of Outer Space Affairs, 1, On-line, Internet, 15 December 1997, available from http://www.un.or.at/OOSA_Kiosk/coprep/1994/cop942a.html. See also *Committee on Peaceful Uses of Outer Space Vienna, 3-14 June*, 10, On-line, Internet, 1 April 1998, available from http://www.un.or.at/OOSA_Kiosk/curev/os162.html. And “U.S. Walks Out of U.N. Space Meeting,” *Aviation Week & Space Technology*, 25 June 1984, 18.

² “Conference on Disarmament: Overview,” *UNOG: Conference on Disarmament Basic Facts*, On-line, Internet, 23 February 1998, available from <http://www.unog.ch/frames/disarm/disconf.htm>.

³ *Report of the Conference on Disarmament to the General Assembly of the United Nations*, 9 September 1997, 11, On-line, Internet, 23 February 1998, available from <http://www.unog.ch/frames/disarm/curdoc/1476.htm>. See also *Report of the Conference on Disarmament to the General Assembly of the United Nations*, 26 September 1995, 98,

Notes

On-line, Internet, 23 February 1998, available from <http://www.unog.ch/frames/disarm/anualrep/cd1364.htm>.

⁴ Major Jeff Rockwell, AF/JA, provided the author a number of papers on the involvement of the Conference on Disarmament on space weapons; these definitions were extracted from the pages labeled “Compilation of definitions of space weapons,” Conference on Disarmament Ad Hoc Committee on Prevention of an Arms Race in Outer Space, CD/OS/WP.14/Rev.1, 21 July 1986.

⁵ *Committee on Peaceful Uses of Outer Space Vienna, 3-14 June, 7*, On-line, Internet, 1 April 1998, available from http://www.un.or.at/OOSA_Kiosk/curev/os162.html.

Appendix B

Satellite Survivability vs. Anti-satellite Testing

The recent commentary about the Mid Infrared Advanced Chemical Laser (MIRACL) tests against the Miniature Satellite Technology Integration 3 (MSTI 3) satellite implies there is some confusion about what constitutes an anti-satellite (ASAT) test and what constitutes a satellite survivability test. This confusion may be the result of a misunderstanding about the relationship between these two types of tests. They are not, as some might believe, polar opposites, residing at the far ends of a linear spectrum (see Figure 1a). They are, instead, independent variables that define two separate axes: one axis measures how well an event matches an “ideal” satellite survivability test, while the other axis measures how well an event matches an “ideal” ASAT test (see Figure 1b).

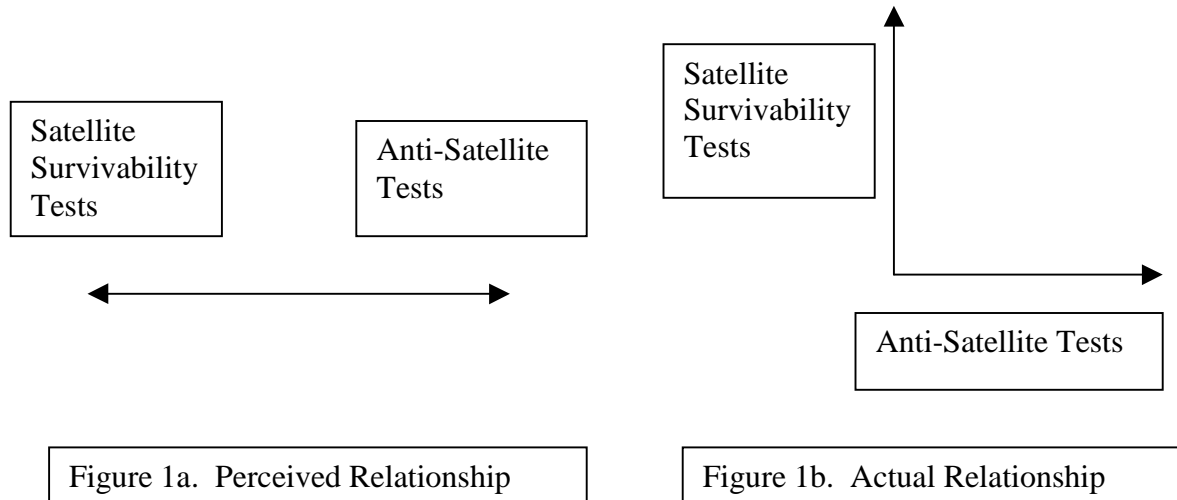


Figure 1. Relationship of Satellite Survivability and ASAT Testing

Together, these two perpendicular axes form a two-dimensional “event space” within which any test against a satellite involving transmission of energy must fall. While this space, in theory, can contain nearly an infinite set of events, considering the events individually does not help resolve the confusion about satellite survivability vs. ASAT tests. Instead, creating four general categories, in a two by two matrix, helps resolve the confusion without oversimplifying the issue (see Figure 2 below).

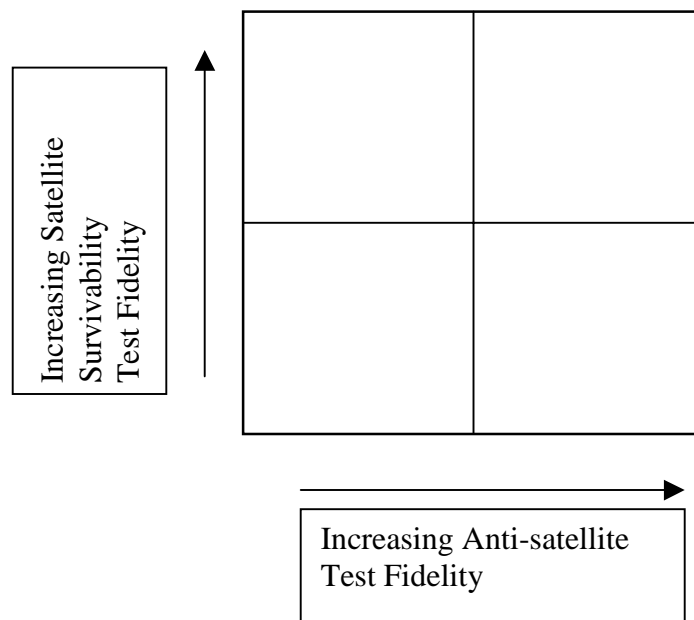


Figure 2. Satellite Survivability and ASAT Test Relationship

The axes of this satellite survivability/ASAT matrix will involve, naturally, the satellite on one hand and the ASAT on the other. Specifically, the vertical axis will be the measure of the level of fidelity that the satellite survivability test has with reality: a combination of the fidelity of the satellite technology being tested compared to actual operational satellite technology and the fidelity of the threat environment that this technology sees compared to the actual threat environment. The origin of the axis will

start with survivability test fidelity that is far removed from real operational satellite technology and threat environments, with increasing distance from the origin meaning that the test gets closer and closer to actual operational technology and threat environments. Since the confusion prompting this discussion – as well as the intense interest in it - results only when a test is done against a satellite in space, the location in which the subject tests occur will always be in space. This is the most interesting test case for satellite owners because it best “reproduces” the real operational environment that the technology must operate within (i.e., it is the real environment). Because of the costs and other limiting factors of getting hardware into space, space survivability tests are not done very often; nevertheless, they are typically the culminating demonstration of a much longer, primarily ground-based test program, and, as such, the ultimate measure of performance for the technology being tested.

The second axis of the two-by-two matrix measures the fidelity of the ASAT technology being demonstrated. The origin would effectively be at the point where the technology has absolutely no relation to any practical weapon system, while the other end of the axis would be where the ASAT hardware is assembled in an actual operational system undergoing either developmental or operational testing. The resulting matrix would look like Figure 3 below, where four categories of interest have been defined: Category 1 – Science Experiment; Category 2 – Satellite Survivability Test; Category 3 – ASAT Test; and Category 4 – Combined ASAT and Satellite Survivability Test. Each of these are explained and illustrated below.

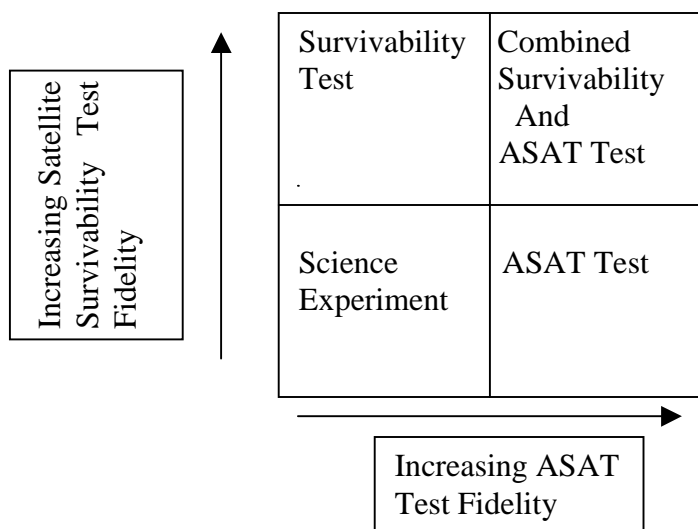


Figure 3. Satellite Survivability and ASAT Test Categories

Since the event prompting the interest in the relationship between satellite survivability and ASAT testing is the MIRACL illumination of the MSTI 3 satellite, all the examples illustrating the four matrix categories are for a laser weapon. However, it is important to note that the categories could just as easily be illustrated by other types of ASAT technology.

In the matrix, Category 1 occurs where the operational fidelity of both the satellite technology and the ASAT technology is low: this is the Science Experiment category. An example of a Category 1 test is a low-power tracking laser being used to illuminate a specialized laser detector on a satellite. While this test tells the laser people something about their ability to hit a satellite, and the satellite survivability people something about their ability to detect and geo-locate a laser illuminating the satellite, it is not really a satellite survivability test or an ASAT test: it is basically a science experiment. There are variations in the category, of course, depending on the details of the test. If the tracking laser were at a scientific site with no possibility of performance as a weapon, the test would be closer to the origin; if the tracking laser were co-located with a weapon

system, then it would push the test along the axis, closer to the border with the next category. Similarly, if the detector on the satellite was packaged within a short-life, one-of-a-kind experimental strap-on, the test would be close to the origin; if the detector were packaged in a long-life, efficient arrangement designed to integrate easily into a satellite attack warning black box on a host satellites, it would be very close to the border with the next category of test.

Category 2 occurs where the operational fidelity of the satellite technology is high but the fidelity of the ASAT technology is low. An example of this would be an on-orbit test of an actual satellite sensor using a modified on-board calibration device, like a small laser diode. The calibration device might produce the same energy level on the satellite sensor that a powerful ground-based laser weapon could produce, but the calibration device in no way resembles any practical weapon system, so would not constitute an ASAT test. Therefore, a Category 2 test is a pure Satellite Survivability Test. It must be noted that this type of test is not necessarily the most reassuring kind, since a calculation of expected energy levels at the satellite has to be done to know how much to alter the calibration device to produce the right effect; also, other weapon system effects, such as tracking error, would be absent, possibly making the test a “worst case” event for the satellite.

Category 3 occurs where the operational fidelity of the satellite technology is low while that of the ASAT is high: a pure ASAT Test. This would occur when a prototype ASAT weapon was being calibrated by projecting energy against a specialized sensor on a test satellite: it would provide the ASAT useful data for understanding weapon

performance, but would provide little useful data to satellite owners/operators since the specialized detector would not resemble any of the sensors on an operational satellite.

Finally, Category 4 occurs when the operational fidelity of both the satellite technology and the ASAT technology is high: this would be the result when an operational satellite was irradiated by a prototype/operational laser ASAT. This is a Combined Satellite Survivability and ASAT Test. This type of test provides unique data that cannot be gotten from the other three categories, and would seem to be the natural culminating test for both satellite survivability and ASAT technology.

It is important to note that the category of test is not based upon the results of the test: that is, just because a Category 3 or 4 test occurs, **it does not mean that an ASAT capability has been demonstrated.** What it does mean is that some performance aspect of a potential ASAT system has been measured, and additional understanding of the system now is in hand, enabling further progress to be made on its development. Stated another way, specifically regarding the MIRACL test against MSTI 3, this means that, just because MIRACL illuminated MSTI 3, it does not mean that MIRACL demonstrated an ASAT capability. In fact, if the basic ASAT system hardware being tested is somehow modified, as in MIRACL's case with its power level, then the test moves down the axis of fidelity toward a survivability test. Given the integrated nature of the high-power MIRACL system, and previous Army discussions about testing the laser as a contingency ASAT for USSPACECOM, some observers seem to believe it strains credibility to claim that the test has moved completely out of Category 3 and into Category 1, i.e., is a pure Survivability Test. Nevertheless, this could legitimately be the

case if the modifications to the MIRACL system for this MSTI 3 test were actually substantial, reducing the fidelity of the ASAT technology beyond a critical point.

One final observation must be made on this point: if the MSTI 3 test were not about the highly-sensitive ASAT issue, then DOD would come under severe criticism if it did not extract the last bit of technical information out of this test from both the satellite's and ground-based weapon's perspective. Only because of the sensitivity to ASAT must the Army make changes to the MIRACL system to make it less capable and forgo the opportunity to actually determine if it does, indeed, have an ASAT capability. Time will tell if this situation will alter sufficiently for a future MIRACL Category 4 test to be planned and executed against a different cooperative satellite, now that MSTI 3 has dropped from orbit and re-entered the earth's atmosphere.

Appendix C

Space Weapon Phenomenologies

The seven weapon phenomenologies selected have both historic and practical origins. There have been historic anti-satellite (ASAT) systems that have been armed with nuclear warheads and kinetic energy weapons; the Soviets have also been credited with developing radio-frequency (RF) and laser capabilities that could perform the ASAT mission.¹ The U.S. has studied the potential of a space-based neutral particle beam device as an ASAT in the mid-80's.² The Soviets were suspected of looking at high power microwave (HPM) effects for the ballistic missile defense mission as early as the mid-1980's, and the Chinese have talked about using HPM against all manner of military targets, including satellites and missiles.³ Finally, information warfare (IW) capabilities have received extensive coverage recently, with speculation that IW attacks could be made against all manner of targets, including satellite systems.⁴

As for practical origins, the seven selected phenomenologies cover both the electromagnetic spectrum and the range of readily conceivable space weapons. RF, HPM, and laser weapons span the electromagnetic spectrum from the longest radio waves to the shortest ultraviolet light waves. And nuclear weapons can create hard radiation bursts that fall even further toward the short wavelength end of the spectrum; a hybrid system, nuclear-pumped x-ray lasers, would also fall at the very short wavelength end of

the spectrum. Kinetic energy and particle beam weapons, and nuclear warheads in some applications, cover the physical, versus electro-magnetic, attack modes. Information warfare weapons do not represent a different way of transmitting energy to a target, but instead use RF or laser energy to attack the information within systems rather than the hardware of the system; nevertheless, IW is sufficiently unique to warrant its own category. Together, then, these seven phenomenologies cover a host of potential space weapon concepts.

However, there is need for a final note. Other methods of negating targets are possible, at least two of which readily come to mind. It is possible for a weapon satellite (or the space shuttle) to do a close approach to a target satellite and “spray paint” its surfaces: this could cause optical sensors to cease working or catastrophically ruin thermal balance of the target satellite. Similarly, a remote manipulator arm (or astronaut) could physically cut cables or otherwise perform some act that interferes with the target’s mission. While either of these attacks is possible, this paper does not believe that they are plausible and therefore does not include these space weapon “phenomenologies” in the space weapon taxonomy. However, given that the taxonomy is established, and the criteria for defining the impediments stated, subsequent work could be done to add these, or other exotic concepts, to the taxonomy with little additional effort if the need arises.

Notes

¹ *Soviet Military Power* (Washington, DC: U.S. Printing Office, 1985), 43-45. See also *Soviet Military Power* (Washington, DC: U.S. Printing Office, 1986), 46.

² The author saw such an analysis while working on the Neutral Particle Beam Integrated Space Experiment (NPBISE) at the Air Force Space Technology Center (AFSTC) during 1987.

³ *Soviet Military Power* (Washington, DC: U.S. Printing Office, 1987), 51. Also *Soviet Military Power* (Washington, DC: U.S. Printing Office, 1985), 146. And Michael

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⁴ David A. Fulghum, "Cyberwar Plans Trigger Intelligence Controversy," *Aviation Week and Space Technology*, 19 January 1998, 52.

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